COLOR

IN THE

SCHOOL-ROOM.

A MANUAL FOR TEACHERS.

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PREFACE.

In teaching color to young children there is a great difference of opinion as to methods, just as there is a difference of opinion regarding all other branches of education at the present time. Indeed, color teaching as a systematic branch of primary education is in its infancy, consequently each educator with positive ideas on the subject ought to give a fair consideration to the opinion of all others who have experience in general education and interest enough in this branch to devote to it any considerable thought.

In teaching color two things at least are necessary. First, we must have some standard to which we can refer all colors. Second, we must have some nomenclature by which colors can be known and referred to. In the spectrum are an infinite number of hues, six of which at least are well separated from each other and by general agreement are accepted as natural standards: Red, Orange, Yellow, Green, Blue and Violet. With these six colors either in pigments or in colored lights we may very easily imitate the intermediate hues of the spectrum. Therefore, having these six colors established and named, if we can mix two of them in a definite proportion of each and record this mixture in mathematical terms, we secure a nomenclature for the intermediate hues and other combinations. If the proportions used in combinations could be determined by the measurement or weight of the pigments employed there might have been in use, ages since, some accepted nomenclature, but no argument is necessary to prove that we cannot establish the hue of a compound color by either weighing or measuring the pigments used to produce it. Accepting this condition, we must look for some other available means, and in the Maxwell

rotating disks we find the most practicable device yet known, as by them we measure surfaces of reflected light instead of weight or bulk of pigments. By these we are able with six standards to produce close imitations of the intermediate spectrum hues, and other combinations. Inasmuch as pigment colors cannot approach in brilliancy the colors of light, and therefore all art is at best a poor imitation of nature, we must conclude that at present, at least, we cannot establish those absolutely perfect standards and that definite nomenclature which is possible in the more exact sciences, but this should not deter us from attempting the best that now seems possible, trusting to others with greater experience or the aggregation of the experience of many others in future to perfect the work of the present or to demonstrate new methods based on new discoveries and greater information. Those artists who begin color education with three pigments, a red, a yellow and a blue, and assume to produce from them a harmonious scale of hues somewhat in imitation of the solar spectrum on which to base their teaching, fall short of their aim in at least two important points. First, they do not approach very closely to the spectrum hues, as it is impossible to do with any single set of three pigments, and secondly, they have no accurate and uniform means of naming even those special hues which they do make. Therefore the next teacher of color constructs another and different standard, a harmonious scale which is as devoid of all nomenclature as the other, thus making confusion worse confounded As the present indefinite condition of color in art is the result of a trial of this method for hundreds of years, it would seem at least reasonable to attempt a solution of the difficulty in another line of investigation which promises so much better results.

Instead of assuming that there are three pigment colors from which all colors in nature may be produced, as is done in some professed treatises on color, we deny that all colors can be made from ANY SINGLE TRIAD OF PIGMENTS. Basing our investigations on the fact that all the colors in nature

are produced by the mixture of colored light and not of pigments, and on the accepted fact that in the solar spectrum, we have a complete analysis of light into its simple elements and that with six of those colors we can by mechanical combination very closely imitate all the intermediate hues, we attempt to suggest a line of color study and investigation which shall at once be simple and scientific. We also maintain that this line is as applicable to æsthetic effects in its higher grades as any other system which is not founded on a scientific basis. If there is truth in the theory at present accepted that white light, the sum of all the colors in nature, can be produced from three colors, these certainly are not red, yellow and blue, but, according to the Young theory, they are red, green and violet.

If, however, we accept the six spectrum colors, we can produce with them very close imitations of the other spectrum colors and the other colors of nature, both in light and in pigments. Therefore as nature has provided itself with these colors which have been so long recognized and accepted as standards, why not adopt them and save further trouble?

While it may be possible to produce an unlimited number of other scales of colors which may be near or remote imitations of the standard nature has set for us in the solar spectrum and made familiar in the clouds, who shall assume to say which of them all must be accepted as a universal standard. Having adopted the six spectrum colors as standards, we believe the rotating disks are the most practicable and valuable means for making combinations and for establishing a scientific nomenclature of colors. Therefore an educational line of colored papers has been manufactured, which is offered as a fair representation of the standards and some of their combinations with each other and with black and white by means of the rotating disks. To these may be added many colors, possibly more beautiful in themselves, and in their combinations, than is found in this limited educational list, but when the results educationally are considered we claim that the superiority of these colors for educational work will be generally conceded.

Thus far the study of color has been from two different stand-points, and little attempt has been made to combine the two in any practical system. The scientist has analyzed sunlight and by experiment demonstrated many valuable facts concerning the laws which govern the colors of objects in nature. By the artist these demonstrations are deemed to be of very little value, because the scientist must deal with the immaterial colors of light, while the painter has only to consider the use of pigments, hence there is very little in common to both. But to an educator who is neither a professional scientist nor an artist it seems that, inasmuch as all color is derived solely from one source, namely sunlight, there must be a philosophical connection between the two classes of students that ought to be established. The artists on one side assert that there are three pigments, red, yellow and blue, from which all others can be made, and their natural deduction from the proposition is that there can be no mathematical or mechanical formulas established for the construction of colors and hence no rules for producing æsthetic combinations of colors, consequently all art education in color must be imparted personally to the pupil by a teacher who has himself received a complete art education. The scientist separates sunlight, the source of all color, into its simple elements as shown in the solar spectrum, and with these colors he produces by combination various other colors which may be definitely recorded and shows that all the colors in nature are produced by a separation of these elements by methods for which he has formulated plausible theories.

It is the object of this book to harmonize these two phases of color education and to present apparatus and material for primary color teaching, also furnishing the primary teacher who may not have been favored with an art education, with sufficient information to begin the use of the material at hand in a systematic way and to inspire a desire for further information in this most fascinating line of investigation. We claim that, as stated by the scientists, the solar spectrum gives us

the colors from which all other colors in nature are produced, that all the effects seen in nature by the artist are produced by a combination of these colored lights which are reflected to his eye, and hence his office is to imitate such colors to the best of his ability with the pigment colors at his command. The study of color is one thing and the study of pigments is another, although practically and closely related to it.

If color teaching is to be accomplished by any other method than personal instruction there must be some systematic nomenclature of colors which shall be as definite as possible, by which the printed page may communicate information in this as well as in all other branches of education.

The instruction in our public schools should aim at such practical and wage-earning results as are compatible with true education, and hence in teaching color those scientific facts should be emphasized which when understood will avoid that defect which a prominent writer attributes to English manufactures previous to the revival of art in manufactures which was inspired by the great world's exhibition of 1851, when he says:—

"Color, a universal source of enjoyment, so essential an element of decorative art, has not been hitherto the subject of such investigations as to place its powers, harmonies and discordances among matters of scientific certainty. A few traditionary dogmas have been the only guide of ordinary workmen, while success in design, as well as in the higher regions of art, has been dependent upon that rare union of faculties vaguely denoted by the indefinite, unsatisfactory term, 'taste.'"

No candid student of this color question will deny that all true laws in harmonies and contrasts are as applicable to high art as to decorative art.

Hitherto all attempts to teach color in the primary grades, if governed by any knowledge of the subject, have been almost wholly from the æsthetic side, while the science of color as briefly suggested in the school text-books on physics has been separated from the artistic consideration of the subject. Al-

though from a scientific stand-point the claim has constantly been made that the solar spectrum furnishes the only standard of colors which is worthy of the name, yet few artists have been willing to acknowledge this fact, or if they have done so it has been with a shrug of the shoulders. A striking illustration of this statement is found in the elaborate color chart of Dr. Hugo Magnus and Prof. B. Joy Jeffries, published a few years ago. While the red, orange and yellow given in this chart approach the spectrum standards, the green, blue and violet vary widely from spectrum colors and the shades and tints are made up without strict regard to scientific truth. And if this is the case with so good an authority as Dr. Jeffries what could be expected of the average artist and art teacher? It has often been said that while the colors of the spectrum are well known they can not be used in any way for establishing standards. This proposition we do not admit, but, on the other hand, affirm that the spectrum is the only source from which to determine standards and that the combinations of the colored rays of light, from these standards without the mechanical mixture of pigments, are the only sources of other standards to which all colors must be referred. Even the best educated eyes do not agree as to the more subtle color combinations, but this is also true in music and literature and is no argument against the possible establishment of a science of color which shall apply to art. If things assumed to be true in this book are later proved to be untrue it will be nothing more than has occurred in similar attempts along other lines for ages. Therefore we begin with the simplest problems in color and give only those facts necessary to present this phase of the matter, namely, color education, leaving the study of the deeper truths to be presented to those who care for them by scientists and artists who have written and will continue to write more elaborate treatises on this subject. The necessity for condensation makes it impossible for us to state all the facts with such scientific exactness as would naturally be desired by critical readers, but an attempt is made to avoid any statement that

may be misleading or is absolutely incorrect. In some cases repetitions of statements occur because it seems desirable to bring them into connection with new truths or theories more forcibly than could otherwise be done.

The book is not in any sense a manual of instruction as to the details of teaching color, neither shall we undertake to say exactly which combinations of colors are the best. But the general laws of color and color combinations are so stated as to give the teacher hints as to the directions in which she may expect to find good combinations, so as to help her to feel the combinations for herself and lead the children to the same results.

A review of the various authors on color has convinced us of the want of some popular elementary treatise concerning this subject, a want that is at least suggested by the fact that the erroneous statement that blue and yellow light combined make green occurs in at least three valuable and popular books. First, in a recent text book prepared especially for primary education in natural sciences. Second, in a valuable treatise on water-color painting. Third, in one of the most popular and standard cyclopedias. How many more similar errors may be found by more extended examination remains to be seen, but these serve to enforce the fact that very little thought has been given to the science of color by writers on art subjects.

The last two chapters of this book are written by a teacher who has had considerable experience in color instruction in the public schools. They are intended chiefly as hints to beginners in this line of work, as each teacher will, of course, adopt certain methods of her own, as they from time to time suggest themselves to her. A list of a few books of moderate size and cost is appended, to which any one may refer who has the interest to warrant a little time for the further investigation of a subject which becomes very fascinating to those who are willing to enroll themselves as its votaries.

Perhaps no other single book will give so clearly and briefly

the general information on color required by the teacher as the Student's Text Book of Color; or Modern Chromatics with Applications to Art and Industry, by O. N. Rood, Professor of Physics in Columbia College, D. Appleton & Co., New York.

Another valuable book is The Theory of Color in its Relation to Art and Art Industry, by Dr. Wilhelm Von Bezold, Professor of Physics at the Royal Polytechnic School at Munich and Member of the Royal Bavarian Academy of Sciences, Translated from the German by S. R. Koehler, with an introduction by Edward C. Pickering, Professor of Physics, Massachusetts Institute of Technology, L. Prang & Co., Boston. This book is more extended in certain lines of thought and not as comprehensive as the first named and is invaluable to any one interested in the subject of which it treats, namely, the application of the science of color to the fine arts.

A third book worthy of consideration is The Laws of the Contrasts of Color and their Application to the Arts of Painting, Decoration of Buildings, Mosaic Work, Tapestry and Carpet Weaving, Calico Printing, etc., by M. Chevreul, Director of the dye works of the Gobelin, George Routledge & Sons, London. The author of this work was in charge of the dye works of the celebrated Gobelin manufacturers and all his deductions are in strict accord with actual experience. On the subject of harmonies and contrasts no other work of its size contains so much truth.

In addition to what is found in these and other books on color, much information may be obtained from any modern editions of cyclopedias under the two heads of Light and Color.

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CHAPTER I.

THE NECESSITY OF COLOR TEACHING IN PRIMARY SCHOOLS.

WHY is it essential to teach children the facts relating to color?

Because there is so much color in nature and we aim to bring the child into the closest possible sympathy with nature. Because his color perceptions need cultivation, just as much as his musical or mathematical perceptions, his appreciation of a correct literary style, or in fact, any of his faculties that one may choose to name. Unless he is color-trained he cannot enter into a full enjoyment of the beautiful, which the Greeks regarded as equivalent to the world itself, using the same word to denote the earth and the beautiful.

We should teach the child color not only for the sake of beauty but also for the sake of business. Early color education, properly conducted, will detect any tendencies toward color blindness which he may possess, may help him in the fortunate choice of a vocation and prove a strong factor of his success through life, besides adding immensely to his avenues for healthful enjoyment in all the paths of life.

That the harmonious combinations and contrasts of different colors constitute one of our greatest sources of pleasure, few of us will care to deny, and it is equally evident that in numerous lines of business an understanding of the correct use of color is of great commercial service. But while the value of a trained color-sense is unquestioned, we are confronted with the sad reality that half the people of the present day have no true perceptions of the values of colors, or of the effect of colors on each other in combinations.

Even a casual consideration of this subject must convince us that for the majority of the human race to be ignorant of the simplest principles of the harmonies and pleasing contrasts in colors is simply absurd, and it follows that a considerable percentage of them are regarded as color-blind because they are color-ignorant.

It is high-time to set aside the notion that a knowledge of colors and their combinations in the arts is beneath the dignity of business men and also of women of affairs. The fact that any people who are ambitious to excel in the industrial arts, to say nothing of fine art, must in their primary education lay the foundation for a knowledge of the beautiful in form and color is too patent for argument, and if there is to be any reform in the community in this direction it must come through the education of children. Until within a very few years there has been no teaching of color in the primary schools, the only instruction ever attempted being confined to the closing months of a high school or college course and limited to a few general observations in connection with the study of physics. By this time the perceptive faculties which the pupils possessed in early childhood have become measurably blunted, unless, as in rare cases, they have received careful cultivation along those lines of research into the mysteries of nature which should be delightful to every child. Consequently these advanced pupils are not in the best condition to appreciate and utilize what little color teaching is given them.

That color is one of the earliest subjects which should be taught in any educational course is evident from the fact that some bright color is the first thing to attract the infant's eye, winning his notice before he pays any attention to form. No branch of primary education is more lauded in these latter days than form study, which can be made a fascination to the youngest pupil and is the basis of drawing in all its varied departments, but color comes before form and accompanies it through all its exhibitions in art and nature. The study of color and form should therefore go hand in hand, and then we

may hope to see a rapid crystalization of certain truths regarding color which have been felt but not clearly stated by the great artists of the past. This result can only be reached through many experiments and not a few blunders, because of the present lack of instructors who are well qualified to lay down and successfully carry out a general scheme of color-education. That the few normal art schools which are located at some of our educational centers are doing excellent work and making themselves widely felt in the right direction through their graduates is not to be denied by those conversant with the facts, but as regards the rank and file of public school teachers it must be admitted that our successful teachers are not experienced artists and the distinguished artists who might be called in to carry on the work are not skilled in educational processes. The two classes must come together, so that those things in art and nature which are now mysteries to the masses can be made as simple as those other things in science which were but lately wrapped in obscurity, so far as the multitude were concerned. If new truths are being daily discovered in science by men who have not hitherto been regarded as learned, is it impossible that we may yet see Newtons and Edisons in art who shall be able to hand down to the common people the great mysteries of the beautiful?

Granting that the subject of color has an æsthetic and practical value and should be taught in our public schools, a multitude of queries as to time, ways, means and aims will force themselves on the teacher who is about to enter this untried field of instruction. Some of these questions it will be possible to answer in advance. The uncertainty which clings to others can only be dispelled, if at all, in the school of experience. In the color-education of the past, two things, which although intimately related in practice are absolutely distinct, have been sadly confused. The training of the eye to match and analyze colors and to make good combinations and detect bad ones, is wholly separate from the ability to produce the various colors with pigments. The first process is adapted to

the comprehension of the youngest children and may be carried on in a large school and at a moderate cost. But while this grade of work is being done the minds of both teacher and pupils should be relieved from the necessity of considering the technical methods of mixing and applying pigments. The eye should first be trained by the familiar use of properly graded colors, ready prepared, and for this purpose no material is as good or as economical as a line of colored papers which represents correct standards. After the children have been taught to recognize from fifty to one hundred or more well-selected colors and to know them as familiar friends in all their best combinations, as well as to avoid the many combinations which are not pleasing, then the use of pigments either in water or oil, with which to match the colors already known and to produce hundreds of others, will add pleasure to the study and require much less care on the teacher's part.

Those natural artists who were born with a knowledge of color have, in spite of poverty, lack of fine colors, and good implements, done artistic work, while other students of "painting" who have been provided with the most expensive materials and implements but without a trained eye for color have been unable to produce even a respectable picture after years of effort, thus showing that the knowledge of color is more import ant than the knowledge of methods. With the very best of training few pupils can become artists worthy of the name, neither, on the other hand, does color-education necessarily have for its end the making of artists. It does aim, however, to train the eye to recognize, compare and analyze colors, and also to teach the names of those colors.

The teacher who has persuaded herself of the necessity of teaching color in the school-room will naturally wish to begin with the little children. But, as has already been intimated, if she is wise, she will not undertake to teach them anything of the science of color. Their color-sense does not depend on that science, neither will their ability to combine color, after they have been properly instructed. Nevertheless, while it is

unnecessary for the child to master the science of color or even to know that there is such a thing, it is important that the teacher herself should be thoroughly conversant with the essential facts pertaining to the science, otherwise her teaching is very liable to be "wide of the mark." Many books have already been published on the science of color and the artistic use of color. But whether any or all of them are calculated to give the unscientific and inartistic primary teacher just the help needed may well be questioned. What she wants to know is how she can best instruct her pupils to distinguish the different colors from each other and give them correct names, as well as to know which of them can be brought together with good effects.

CHAPTER II.

COLOR DEFINITIONS.

AN attempt will be made in this chapter to explain certain terms pertaining to the science of color which are liable to occur at any point in the following pages, so that they may be understood whenever met, although the reader must remember that the use of some of these terms is so varied by different authors of recognized authority, and that a number are so vaguely employed in general, that the task of evolving definitions which are entirely satisfactory to all who deal with color may be regarded at the outset as almost hopeless. This chapter, however, undertakes to give the most frequently accepted use of the commonest terms, and also to modestly suggest a more definite basis for color terms, something which should interest all artists, as well as all teachers of color.

Pure Color.—A pure color, otherwise called a saturated color, is the most intense form of that color without the admixture of white, as for instance, the reddest possible red and the bluest blue, etc. The same meaning is sometimes intended by the phrase "a full color." A color is pure as it approaches the corresponding color found in the spectrum, but all material colors contain a large percentage of white light. We must, therefore, select the quality of color by comparison with the spectrum, and then get the purest or most intense expression of that color which is possible in pigments. For example, we must for the green select a color which when held in a strong light will show the same kind of green as that part of the spectrum which is by general consent called the greenest green, and then we must get the most intense expression of that green which is possible with the pigments at our com-

mand. The color will then fall far short of the spectrum standard, because all surfaces reflect some white light, which inevitably reduces the fullness of the color. For a further explanation of this reflection of light see Chapter IV.

Purity.—The word purity is often used by artists in a sense entirely different from pure when applied to a color. A painting which has no tendency to dullness or grayness in the tints is admired for its purity.

Local Color.—This term is applied to the natural color of an object when seen in ordinary daylight and at a convenient distance, as a sheet of paper at arm's length, a tree at twice its height, etc. The true local color of any object is not visible in full sunlight, being then lost in light, nor in shade, for then it is more or less absorbed in darkness, or it may be altered by accidental influences, such as reflections from surrounding objects or other effect of colored light. Owing to these influences it follows that in nature very little of the local color of an object is depicted, neither should the student be anxious to show it as he knows it to be, but rather as it appears at the time when he is studying it.

Accidental or Complementary Colors.—When the eye has been strongly impressed with any particular species of colored light, and when in this state it looks at a sheet of white paper, the paper does not appear to it white, or of the color with which the eye was impressed, but tinged with a different color, which is said to be the accidental of the first color. If we place, for example, a bright red disk upon a sheet of white paper, and fix the eye steadily upon a mark in the center of it, and then turn the eye on the white paper, we shall see a circular spot of bluish-green light the size of the disk, but much less intense. This color, which is called the accidental color of red, will gradually fade away. The bluish-green image of the wafer is called an ocular spectrum, because it is impressed on the eye and may be carried about with it for a short time. It is also called the opposite color, because if a color scale is formed by uniting the solar spectrum at the ends,

thus forming a circle, the accidental colors are approximately opposite each other. The accidental colors are also called complementary colors, because if the two colors reduced to equal intensities are combined they form white light, thus being complementary to each other. The accidental color of black is white. The term harmonic has been applied to the accidental or complementary color adopted from the theory of music, and it is generally supposed that complementary colors harmonize with each other, although this does not seem to be true in its best sense.

Broken Colors or Broken Tints.—These words when properly used apply to colors mixed with gray, i. e., with both black and white.

Brightness or Luminosity.—The brightness or luminosity of a color is determined by comparing it with neutral grays. If, for example, we place on a rotating spindle a large red disk and in front of it combined white and black disks of a smaller diameter, and rotate them, the red is not changed, but the white and black disks are resolved into a gray. The white and black disks may be adjusted till the gray seems to be of the same brightness as the red, i. e., neither lighter nor darker. When this result is secured the gray is the measure of the luminosity of the red, and may be recorded by the proportions that the white and black sectors each bear to the whole circle.

Ray of Light.—The finest supposable element of light-impression in the eye.

Beam of Light.—A number of rays.

Primary Colors.—In the scheme of color based on the mixture of red, yellow and blue to make all others, these three are called the primary colors.

Tertiary Colors.—The various colors made by mixing orange, green and purple pigments are classed as russet, olive and citrine, and are called tertiaries. Orange and purple, mixed in various proportions, form a line of russets. Purple and green form olives and green and orange produce citrines.

TINT.—In a definite sense this word seems to be applied by the best authorities to any color mixed with white or reduced by white light, and in opposition to shade or shadow, which inindcates the absence of light, or in material colors the mixture of black. In nature the scale of a color in tints and shades is seen on the surface of a cylinder where the local color occupies but a narrow stripe and runs into tints toward the high light and into shades and shadow on the opposite side. In some recognized authorities the term tints is confounded with hues, but there seems to be no good reason for this use of it. Shades is often used in a similar way, but all such significations appear to add unnecessary difficulties and to make still more indefinite a subject already attended with no little confusion.

HUE.—It is very difficult to express any difference between a hue and a color where the word is used alone, but the term "hue of a color" should be applied exclusively to the modifications which a color receives from the addition of a quantity of another color, usually a comparatively small quantity. For example, a blue with a small quantity of green added gives a green hue of blue. If so much green is added that the resultant color appears more like green than blue it becomes a blue hue of green. There is a point at which it may be difficult to decide whether the combination is blue or green, at which stage it may with some justice be designated blue and green.

TONE.—Any attempt to express the shades of meaning given to this word in high art would be useless, but it is evidently derived from music and has the same general meaning as applied either to music or color. A full-toned picture, for example, is one in which the full or saturated colors are used freely, and a deep or low-toned picture is one in which the colors are mixed with black, or colors nearly allied to it. But one writer on art, after devoting considerable space to an explanation of the term, remarks, "We use this term very freely, far too freely, and thus render its signification very vague." Under

these circumstances it would not seem very desirable to introduce the word here, or to attempt its definition if it had no more definite meaning, but there is one use of the word for which there seems to be no recognized substitute. If we have a pure or full color graduated by a succession of steps to a light tint on one side and a deep shade on the other we have a scale of that color, so that each step is called a tone in that color scale and the full color may be called the key or key-tone in that scale. Thus far there seems to be this one definite use for the word, and possibly it would be well if the meaning of tone could be limited to this use exclusively. If we in connection with this definition of tone apply "hues" to indicate the variations in the key-colors and designate each key-hue by its symbol, using tones for the modification of each key-color by the mixture of white and black, much seems to be gained in definiteness of terms.

In this connection an English writer of note says: "Tints contain differing amounts of white, shades contain differing amounts of black, broken tints contain differing amounts of gray, all these are tones. When a series of tones is said to constitute a scale it is formed by the addition of equal increments of the modifying element. Each hue admits of three scales, the reduced scale made up of tints, the darkened scale made up of shades, the dulled scale made up of broken tints."

This division of each scale into two parts, one above and one below the normal color, is not common, if indeed it is desirable.

A Scale of Color.—By these words we mean the entire range of tints and shades between the pure or saturated color and white on one side and black on the other. See definition of tone.

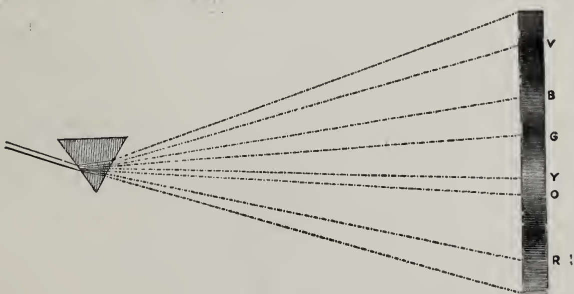
This word scale is sometimes applied to the various hues of a standard, thus a scale of yellows means the various hues from green yellow to orange yellow, but this double use of the same term tends to confusion, and as the first use is the more common and important it would be well if it could become the only one.

This term is also employed to denote the relative degrees that the tones of a picture hold to nature or to each other. For example, a picture may be executed in a high scale when pure white is introduced and the tints are graduated with reference to that color or descend rapidly from a small portion of high light to a middle tone, but graduating more slowly in the deeper tones.

Cold Colors.—The cold colors are said to be green, blue and violet.

Warm Colors.—These are designated as red, orange and yellow.

The Solar Spectrum —When a beam of light is admitted into a darkened room through a very narrow slit, and transmitted through a triangular glass prism on to a white surface within the room, it is separted into an indefinite number of colors. Under such circumstances this beam of light is readily analyzed, as it forms a variegated band of colors, beginning at one end with a dark crimson hue, and gradually changing



into a bright scarlet, which runs into an orange and then through yellow, green and blue to violet, which color gradually fades away into the darkness from which the red at the other end emerged. This display is termed the solar spectrum, and constitutes the only known standard of colors.

If in place of a solid glass prism we use a triangular glass bottle filled with bisulphide of carbon, a longer spectrum is

formed. The explanation of the phenomenon of the spectrum is found in the fact that the beam of sunlight is composed of a great number of different kinds of rays which in passing through the prism are refracted or bent from their direct course, and some are bent more than others; the red least of all and the violet most. This refraction is illustrated by the cut, on the preceding page, in which the dotted lines represents the rays of light passing through the triangular prism with V (violet) at the top and R, (red) at the bottom. If the beam of light can be brought into the room horizontally it is better to use a vertical slit and stand the prism on end, thus securing a horizontal spectrum instead of a vertical one.

Harmony.—Two colors are said to be in harmony when after being placed in juxtaposition the effect is pleasing to the eye. Harmony may be divided into Harmony of Analogy and Harmony of Contrast. Harmony of Analogy may exist between two tones of the same scale, or between two hues in both of which some one color predominates. Pairs of complementary colors or accidental colors approximate harmonious contrasts, but do not always seem to fulfill all the necessary conditions, and thus far no definite rules for producing this effect in perfection have been elaborated.

Ruskin gives the following additional definitions :—

Harmony of Contrast.—Two very distant tones of same scale of hues. Tones of different depths belonging to neighboring scales harmonize.

Harmony of Analogy of Scale.—Different tones of same scale more or less approximate.

Harmony of Analogy of Hues.—Tones of the same or nearly the same depth of neighboring scales.

Harmony of a Dominant Colored Light.—Various colors assorted after the law of contrasts, but one of them predominating, as if viewed with a colored light or through a colored glass.

CHAPTER III.

COLOR BLINDNESS.

THIS phase of our subject is considered here by way of emphasizing the necessity of teaching color in the public schools, from a practical stand-point. The term color blindness is so common at the present day that few people are ignorant of its general meaning. The fact that many states employ officers to visit the public schools to determine by examination whether the children have a normal perception of the different colors and the systematic examination of applicants for positions of locomotive engineers and marine pilots make it evident that there is a considerable part of the people whose color vision is defective, and that this defect is a matter of great moment, not only to the individuals themselves, but also to the public, whose lives are liable to be imperiled, unless its existence is discovered. Moreover, the interests of the children are at stake in this matter, because their lifework may turn out a failure, owing to the wrong choice of an occupation through ignorance of the existence of color blindness. A curious thing about this whole subject is the necessity which exists of calling in experts to ascertain whether a company of children who have been for a number of years under teachers supposed to be fully competent to carry them through all the essential educational processes are color blind or not. If color instruction had been properly given there ought to be no doubt in the teacher's mind regarding any pupil. Some adults are, doubtless, to a certain extent color blind who do not suspect the fact, while others would have their alleged color blindness cleared away in a very considerable degree if they should become better informed about color, for, out of the number of people who

are in no sense color blind very few can properly name or describe colors, except in the most general way. They simply have not been taught to recognize and analyze colors and give them correct names.

It has been determined by a series of recorded experiments extending through a period of several years, that about six per cent of the people are so deficient in their perceptions of color that they must be regarded as color blind, as this term is used; but there are so many varieties and degrees of this defect or disease that the general name color blindness conveys a very indefinite impression of the real facts.

Speaking in a general way, color blindness is the want of connection between the light reflected from any object and the consciousness of the person. Experts cannot tell in all cases whether the difficulty is with the eye or the brain. For practical purposes this uncertainty is not important to the primary teacher, because genuine color blindness has thus far been considered incurable, consequently the only important fact for the teacher to determine is whether certain defects equivalent to either partial or total color blindness exist.

If a pupil has no real color blindness, education in color will have the same effect that it does in any other line. A child who is simply dull can make the same progress in color as in any other subject in which he is slow to learn, and because of his general mental incapacity should have special attention paid him by the teacher. On he other hand, if he is really color blind in any degree and the facts can be discerned by the teacher, the pupil and his parents should be informed of the impediment, as the knowledge of it may be of vital importance in choosing his life occupation. If the difficulty is but slight and its nature and extent are known, much may be done to compensate for the unfortunate deficiency, as well as to avoid unjust censure for inattention, which results from a disease or deformity. We shall therefore attempt, in the briefest possible way, to explain the commonest forms of this difficulty and describe the best methods of making the necessary tests.

To a person who is totally color blind all colors appear as different shades of neutral grays. This form is so very rare that it requires little attention here, as it will naturally be discovered in a child at a very early age. Of partial color blindness there are three kinds most common, red, green and violet blindness, the latter being very much less frequent than the other two, and the red being apparently much more so than the green. In the first-named form of partial color blindness the perception of red is very weak, or entirely wanting and the person afflicted with it sees only green, violet or blue. In green color blindness the red and violet are seen and the green appears to be a gray or brown. In violet blindness the perception of blue or violet would be very weak, or entirely wanting. As stated above, this form is very rare, the general difficulty being with red or green.

Sometimes people experience considerable difficulty in remembering the names of the different colors, although the difference between the colors is readily perceived. In such cases the trouble is due entirely to the brain, and much can undoubtedly be done to advance the color education of these people by patient drill. This condition of affairs does not seem to be really a case of color blindness. Therefore all tests of color perception should be entirely separated from the names of the colors, and the only practical resort is found in assorting a large number of different colors which are of such hues as to be definitely classified and yet of sufficient variety to afford a test. A considerable variety of shades and tints of each of a large number of hues should be used. In the absence of any other material easily obtained and sufficiently diversified in colors, Berlin worsteds have usually been recommended, but the teacher who employs in her school work a line of colored papers of suitable variety and selection need go no farther for the very best medium. In fact, it will be impossible for a child who lacks a normal perception of color to receive proper instruction and drill in color for a year or two without showing his defficiency. When this is divulged to the teacher she is in

duty bound to investigate the matter and by long continued tests, if necessary, to determine whether it is a case of genuine color blindness or not.

According to the scientific theory there are three sets of color fibres, or nerves in the retina of the eye, one set being most affected by red, another by green and the third by violet. This theory also assumes that when one of these sets of nerves is paralyzed or becomes inactive the person is made color blind as regards that particular color, consequently we have red blindness, green blindness, and violet blindness. Therefore as the entire paralysis of the three sets of nerves is very uncommon, we rarely meet with a case of complete color blindness. But we do find every grade of this disease, so that it is impossible to draw the line at which a person can be said to be color blind.

The only way to ascertain the condition of any one with reference to his color perception is by having him compare colors and not by naming them. Formerly color charts were used for testing color blindness in children, the teacher showing the colors to the pupils and asking the names. But a child soon learned, from hearing the others recite, which spot was red, which green, etc., so that the amount of information which the teacher was able to obtain proved quite restricted and the natural desires of the child to show that he possessed as much knowledge as his mates stimulated him to unintentionally deceive the teacher. The better way of detecting color blindness is through selections made by each pupil. Let the teacher pick out some one color and, showing it to the child, ask him to choose one or more exactly like it. Then let him pick out others similar in color, the tints of some color and the shades of some color, afterward assorting the different colors. If all colors at different times are persistently confounded with neutrals or yellowish grays there must be a degree of general color blindness. If a child is color blind to red and has a normal perception of green and violet he will see in the various reds and oranges either various shades of neutral grays or

yellow grays. If reds and greens are confounded there is either a red blindness or a green blindness, or both. The violet blindness, if it ever occurs, which is as yet a matter of some doubt, would, of course, be indicated by the confusing of violet and blue with neutrals or with reds.

The number of cases of color blindness which have been carefully tested and the results recorded and published is so small and the conditions as reported are so varied that, thus far it seems impossible to establish any classification which will enable a non-professional to determine just the kind or degree of color blindness which exists in a given case. There are a few things, however, which if definitely ascertained offer direct evidence that this condition of the color sense is abnormal and will warrant the teacher in suggesting that the child be examined regarding his color blindness by an expert.

It is a prevalent idea that the number of color blind women is very much less than that of men, and much time has been spent in debating this question, but some doubt remains as to whether this opinion does not obtain because the girls are brought so much more intimately into relation with colored materials in selecting their articles of dress and in this way come to know the names of colors much better and in fact enjoy a much better color education than the men. A correct decision can better be reached when both the boys and girls receive a systematic color education and their color sense is more equally cultivated. At present this difference seems to favor the theory that a very large part of the apparent deficiency in the color sense of men may be overcome by proper training in childhood.

CHAPTER IV.

THE THEORY OF LIGHT AND COLOR.

HAVING hinted at the necessity of research regarding the science of color by those teachers who wish to give color instruction to children, we shall now attempt for their benefit a condensed statement of the theory of light, and its relation to color, because a knowledge of these things is essential to any clear understanding of the science of color.

About two hundred and twenty-five years ago Sir Isaac Newton accidentally discovered that a triangular prism would transform a sunbeam into a beautiful band of colors on a white surface. This discovery led him to analyze sunlight which is considered as white light, and in consequence it has long been an accepted truth that a beam of solar light is composed of an indeterminate number of variously colored rays, which are distributed into groups termed red rays, orange rays, yellow rays, green rays, blue rays and violet rays. This band of colors, which is obtained by throwing a beam of sunlight on a white surface after it has passed through a triangular glass prism, is called the solar spectrum. Newton himself claimed that the spectrum was made up of seven colors, placing indigo between blue and violet; modern scientists, however, are content to drop it from the list of standard colors, regarding it merely as an intermediate between blue and violet.

The word light as a scientific term is applied to three things. First, it is the name given to the yet unknown physical agent or cause of the illumination and visibility of bodies in nature. Secondly, it indicates the condition of bodies while acted on by such a cause as has just been mentioned. Thirdly, it designates the sensation arising from the reception of its influence on the sensitive part of the eye.

Our knowledge of light is so limited that we can only speak of its phenomena and their laws. All natural objects are obviously divisible into two classes: Those which originally give forth or emit light, and those which do not. The former are self-luminous, being commonly termed sources of light. The latter are commonly termed non-luminous. They may be said to be illuminated, but are, in truth, temporarily luminous.

The lines of luminous action or effect are what we call rays. The emission of light from a luminous body occurs in all directions and always in straight lines. A substance through which light is perfectly transmitted is said to be transparent. Bodies through which objects are indistinctly visible are semi-transparent. Those through which only a glimmer of light is seen, without the form of objects being defined, are translucent, while those are opaque through which no perceptible light passes. In considering these terms, however, it should be remembered that no substance is wholly transparent and no material absolutely opaque. Thin plates of polished glass are commonly called transparent and ground glass and oiled paper furnish good examples of translucent materials. There are no absolute dividing lines between these classes, the terms which are used as a matter of convenience being somewhat indefinite.

In analyzing the composition of sunlight we must investigate the effects of refraction and reflection. When sunlight, commonly called white light, passes through the prism it is refracted, that is, bent from its straight concourse and as each class of rays has a different degree of refraction the several colors are separated and the variegated band of colors results. The rainbow itself is formed by the refraction of light passed through drops of water in the air, instead of through the glass prism.

White light is also separated by reflection as well as refraction. When rays of light proceeding from any source strike the surface of an opaque or a partially opaque object, which is neither black nor absolutely rough, a part of the light is returned from such surface by the process which we call reflec-

tion. If the surface of the object is perfectly polished, as a mirror, all of the light is reflected, unchanged in color, at an angle having a fixed relation to the angle at which it impinged the surface, that is, the angle of incidence is equal to the angle of reflection, and always shows in that single direction the images of the objects from which the rays originally proceeded.

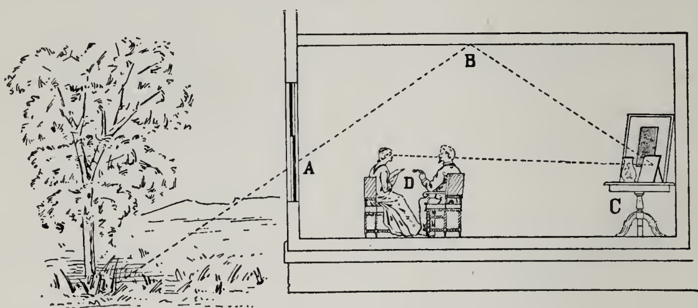
If the surface is perfectly white and rough the light is returned or reflected in a wholly different way, as every point of the surface becomes a center from which the light radiates unchanged in color, in all directions. In surfaces which are neither polished nor perfectly white and rough the two kinds of reflection are combined, but the different rays are never mixed in their effects. The rays reflected from a perfectly-polished surface have the color of the body from which they originally eminated. Those from a perfectly rough surface have only the color of that surface. Those rays reflected from the polished surface are said to be regularly reflected and those from the rough surface irregularly reflected. When a surface receiving light is rough but not white the adoption of a new term seems necessary, in order to express the result which we call absorption, although it may be doubted if this process has ever been as satisfactorily explained as could be desired. Thus aside from the refraction of the prism absorption seems to be another way of separating the innumerable rays of different colors which are contained in white light, provided the white light falls on any other than a white surface. For instance, when a beam of white light illuminates the surface of an unpolished piece of red cloth or paper only the red rays of light are returned to the eye, all the others being lost. For convenience these last-named rays are said to be absorbed. These rays are only lost as regards vision, because their heat and other effects may be retained and exhibited. Why the red rays are returned we cannot tell, although the process is in all probability a different one than that of reflection. When a colored surface, for example, a red surface, is partially polished, as a piece of red glazed paper, a certain part of the

white light impinging the surface is regularly reflected and is mixed in the eye with the red rays. Consequently the color cannot be a full red, but must be a red with more or less of white light, that is, a tint of red. As no material surface is so absolutely rough as not to reflect any white light it is impossible to obtain perfectly pure colors from pigments.

Some writers assert that as we have only to deal with material colors in painting, we do not care to know what is produced by the combination of colored lights as distinct from the mixture of pigments or, in other words, a teacher need know nothing of the science of color in order to teach the æsthetic use of color. In decorative coloring this may be true in the abstract, as the artist is free to make his own selections, but in landscape painting or the imitation of nature the reverse is nearly always true. Seldom, if ever, does the artist have occasion to imitate the local color of any object. All color is modified by high light, shade and shadow and by the innumerable reflections of surrounding objects. In an interior, all objects are modified by the draperies and other furnishings, and in a landscape it is no less a fact that the color of everything is affected by the sky, colored buildings and other surroundings. Speaking of certain experiments in the effect of colored light on colored surfaces, Prof. Rood says: "They are certainly useful in teaching us, when studying from nature, fearlessly to follow even the most evanescent indications of the eye, utterly regardless of the fact that they disobey laws which they have learned from the pallette." The knowledge of complementary colors is also necessary, as it perceptibly affects all shadows, distances against a sky and kindred matters. Prof. Barnard, in his book on "The Theory and Practice of Landscape Painting in Water Colors," writes as follows: "Thus the colors of material objects vary according to the light by which they are viewed. A sand-bank for instance, observed partly in a bright light and partly in shadow, will not appear altogether of its true color, yellow. The part under shadow will not reflect a sufficient portion of yellow

rays, and the bright yellow of the other part will have a tendency to produce on the eye the effect of the accidental color, purple. Some artists, in depicting such an object would at once introduce the accidental color in a pure state, and represent the shadow by a purple tint, but an accurate study of nature does not seem to warrant the total exclusion of the true color of the object in favor of its complementary tint.

A little careful observation will convince any one possessed of good color sense that we usually see but a very little of the color that is all around us in nature. A brief recital of an actual occurrence will, perhaps, be a more forcible illustration than would an imaginary example. Two friends were seated one June afternoon in a room represented in outline in the accompanying diagram. The principal light in the



room entered through a window, A, opening on to a lawn on which were trees near the house, so that nearly all the light entering the room was reflected from the grass and leaves of the trees. The ceiling, B, of the room was a warm gray. In a corner opposite the front window was a table C, with bric-a-brac, among which was placed at the rear a framed engraving with a wide white margin and mat. In front of this was a small mirror and a vase. The vase was tinted a greenish yellow. The friends sat at one side of the room at D, opposite the table, and in such a position that the mirror reflected a portion of the ceiling illuminated by the light from the window.

The gentleman asked the lady, who was an amateur artist, what color she saw in the ceiling overhead, and the answer was gray. He then asked what she saw in the mirror on the table and she unhesitatingly said green, and in fact the mirror was much more green than the vase, both of which were seen in contrast to the white margin of the engraving at the rear. The young lady knew that the ceiling was gray, but not knowing what bit of surface was reflected in the mirror, the white background and greenish vase in proximity to the mirror told her that it was unmistakably green. Now this color which appeared in the mirror was the combination of two colored lights (not pigments) viz., the green light from the grass and foliage and the gray from the ceiling.

This illustration shows that the problem constantly presented to the artist is to imitate in pigments an effect presented to his eye by the combination of two or more differently colored lights, as in nature the local colors are constantly modified by reflected light from surrounding objects and by light and shade. First we must learn to see the colors, and then by experiment find out what available pigments will best interpret them, and it is absolutely necessary that we know the difference in effect between the combination of two colored lights and two pigments representing the same colors, for in some cases the results are nearly identical and in others very different. For example, in some fine water color work beautiful effects are produced by stippling two or more colors together without overlapping the dots of color to any considerable extent, and with a combination of fine dots of blue and yellow a beautiful gray is produced, the two colors being combined in the eye when seen at a distance, whereas if the pigments were mixed the result would be a green. Again, if we spread over a blue ground a yellow veil and view it from a distance we have a gray, but an artist acquainted with the mixture of colors by pigments only would assume that such a condition of things should be represented by green.

Having observed the effects of light on the bodies surround-

ing us, it is natural that theories should be invented to explain those effects and discover their causes.

The ancients supposed that the action of light was instantaneous, but a Danish astronomer named Roemer disproved this idea in 1676 by observing the eclipses of Jupiter's moons and calculated the velocity of light at about 192,000 miles per second.

Of the various theories which have been formulated to explain the method of propogation of light the two known as corpuscular and undulatory have received the most attention. The former, probably originated by Pythagoras and adopted by Newton, supposes that particles or films eminate from visible objects and enter the eye. The theory now generally adopted, for want of a better and known as the undulatory, was first advanced by Huyghens, a Dutch philosopher, in 1690. He maintained that light is propogated by waves or undulations, spreading in every direction from a luminous body, in a substance extremely rare termed ether, which is supposed to occupy all space and all transparent bodies. These waves are thought to be similar in form and action to the sound waves in the air, or the ripples produced on the smooth surface of a pond when a pebble is thrown into it. As so many of the phenomena of light can be satisfactorily explained by this theory it has been very generally adopted by the best scientists of our day, and is now the only one taught in schools and colleges.

The refrangibility of the variously colored rays of light as separated by the prism are in proportion to the number of undulations per second, and consequently in inverse proportion to the length of those waves. Young prepared a table giving the wave lengths in fractions of an inch and the undulations per second of the principal colors of the spectrum. It will be seen by this table which follows, that the red rays have the longest waves, and hence the smaller number to the second, while the violet rays at the other end of the spectrum have the smallest waves and the most rapid vibrations or undulations :—

COLORS.	WAVE LENGTHS IN INCHES.	UNDULATIONS PER SECOND IN TRILLIONS.
Extreme Red	.0000266	458
Red	.0000256	477
Orange	.0000240	506
Yellow	.0000227	535
Green	.0000211	577
Blue	.0000196	622
Indigo	.0000185	658
Violet	.0000174	699
Extreme Violet	.0000167	727

The spaces in the spectrum occupied by the various colors are very unequal, the colors in the red end being crowded together and very much extended at the violet end. The following are approximately the spaces occupied by each, the whole spectrum being divided into 1,000 parts: Red 175, orange 50, yellow 15, green 160, blue 250 violet 350.

As there is no dividing line between the colors any such division must be but an approximation, as for example, the red passes to an orange red and then through a red orange to orange, and no one can say when the red stops and the orange begins.

Having formulated a theory of the transmission of light through space and determined that the rays of white light are separable into various colors, each color having its own number of wave undulations in proportion to its refrangibility, and shown how various surfaces absorb certain rays and give off others, thereby determining their color, it is necessary for our eyes in some way to become differently impressed with the rays of different colors or wave lengths.

Referring to the spectrum, we notice that while there are in it an unlimited number of hues, all of which combined form white light, it has been proved that red, green and violet may be called primary rays, because white light can be made from these three. Therefore it is supposed that in the retina of the eye there are three sets of nerves or senses which are so affected as to carry to the brain the sensations of red, green and violet

or blue. On this theory is based the explanation of the accidental or complementary colors more fully treated in Chapter II.

All students of this subject are aware that there is much discussion as to how many simple colors are found in the white light and what combinations can and cannot be made from the smallest number. As suggested above, scientists claim that red, green and blue or violet are the colors from which all the combinations are produced in nature, while it is asserted by certain colorists and artists that from red, yellow and blue pigments all colors can be made, and that consequently these three are primary colors. But while this question is in dispute between oculists and artists, may we not safely assert that we find in the solar spectrum the necessary natural standards for at least six colors, nearly the same six which are already recognized as the basis of pigment combinations, but which have been adopted from a different stand-point and mixed up with theories of primaries and secondaries? It is evident that from these six colors we can secure a great variety of other colors by combinations and with black and white.

It may be well at this point to say that we shall in the following pages pay but scant attention to the theory of color education which begins with the primary colors and proceeds to the secondaries and then to the tertiaries. The children can just as well be taught the six colors without any such groupings as to be drilled in these divisions which result in mixing pigments rather than from color analysis. The first plan is more desirable from the fact that the orange, green and violet of the spectrum cannot be as correctly imitated by the mixture of the red, yellow and blue pigments, which will match the red, yellow and blue of the spectrum, as by the use of other pigments, either singly or in combination. For example, a red that will make the best orange with yellow will not make the best violet with the blue of the spectrum, while a blue which will best combine with a red to make a violet will not make the green of the spectrum with yellow.

CHAPTER V.

IS THERE A SCIENTIFIC STANDARD OF COLOR?

BOTH the scientists of our day and those of previous generations have devoted much time to the study of the solar spectrum and in their analysis of it have discovered many wonderful things having a direct relation to the artistic study of color. Many other things have been from time to time brought to light which, while they possess a direct value to the artist, have never been regarded by him as of much importance. Art has always been taught by artists to their special pupils as a sort of hidden avocation to be known only to the favored few. Consequently any attempt to connect the scientific facts relating to color with the artistic use of colors has been met by the artist with the assertion that science has to deal with immaterial color in the form of rays of light, while the colorist must deal exclusively with pigments, therefore art cannot be governed by any set of rules or bounds. As a result there is to this day among artists and artisans no recognized standard of colors and each member of the guild is allowed to do what is right in his own eyes. For centuries every prominent artist and instructor in color has taken upon himself the task of determining what is the proper and most desirable red, green, etc., setting up arbitrary standards according to formulas of his own, in the expectation that all the lesser lights in the profession will bow down and do him reverence, without question. Under such conditions it is about as easy to do creditable work in teaching as it would be to carry on successful business transactions in a country where the currency has no fixed standard of value.

As a matter of fact the scientists have agreed ever since the days of Sir Isaac Newton that the only scientific standard on which all color-combinations are based is found in the solar spectrum.

It is at once apparent to the unprejudiced mind that there must be some generally accepted standard of color if we are to have any science of color, and that a natural standard is much better than one which is merely arbitrary. The general principle can be safely asserted that if any science or art is to be taught systematically it must, to a certain extent, be embodied in a system of rules, otherwise it will never be understood by people whose intellectual capacity is not above the average.

In view of these diverse doctrines the question naturally arises which side is right, that of the colorists or that of the scientists? Of course it can be urged in behalf of the first class that while most subjects are considered from a scientific stand-point mankind have always been in the habit of regarding others purely on their artistic side, and if anything is to be exempt from scientific rules surely the matter of color must be included in the exceptions. But after taking into account all the tendencies of the times, the thoughtful mind is forced to entertain the query whether, after all, every department of our intellectual and æsthetic as well as of our physical and material life is not dominated by science.

In support of this idea allow us to quote from Ritter in his History of Music: "It is a well-known fact that the æsthetics of any special art rest on the theoretical and historical developement of that art. Æsthetics are so to speak, the summing up, the quintessence of all artistic results gained by philosophical researches in the different branches and forms of this or that particular art, or of all the arts taken in a collective form." Now what has been the "theoretical and historic developement" of the art of music? Here is what Sir George Grove has to say on this point: "In instrumental music there has been a steady and perceptible growth of certain fundamen-

tal principles by a process wonderfully like evolution. There can hardly be any doubt that the first attempts at form in music were essentially unconscious and unpremeditated. Therefore if any conformity be observed in the forms of early music, it would seem to indicate a sort of consensus of instinct on the part of composers which will be the true starting point of its posterior developement. In looking backward over the history of music it becomes certain that a scale adapted for any kind of elaboration of harmony could only be arrived at by centuries of thought. In the search after such a scale experiment, has succeeded experiment, those which were successful serving as a basis for further experiments by fresh generations, till the scale we now use was arrived at."

A comparison of authorities regarding the history of music indicates that for ages rote singing must have been the custom, but that in the early part of the fourth century Pope Sylvester started singing schools, the first of which we have any record in the Christian era. Fillmore says that by this time certain musical formulas had become pretty well established as appropriate to the different feasts and fasts of the church, and these singing schools had for their object the preservation of the established chants. They had to be taught by rote and handed down by tradition, for the musical notation of the time was extremely inadequate.

According to Sir George A. Macfarren: "Pope Gregory in the last half of the sixth century formulated certain modes or keys and he made use of a letter notation, but St. Isadore, the friend and survivor of Gregory, proves that no music of the time of Gregory could be preserved. He says, "unless sounds are retained in the memory they perish for they cannot be written." Even after the staff was invented it was two hundred years more, about A. D. 1200, before there was any mode of indicating the length of tones except as instinct and the accent of the words indicated.

Another author in commenting on this period of musical history remarks: "In the developement of music, art foreran

science and its votaries continued the employment of harmonies which as yet could alone be justified by their beautiful effects, and even musical theories did not for ages to come, perceive the important, the all wonderful bearing of the principles of harmonics upon the subject they treated."

Helmholtz in his Science of Acoustics says: "Every tone gives with the principal strong sound an almost immeasurable number of others which are always heard in a certain order. These are called harmonics. The question is asked why then need there be any particular selection or limitation of the sounds used. Why is it necessary to proceed by steps and forbidden to progress by continuous transitions. It appears that all nations in all times, who have made music have adopted such a selection, although they have not always selected the same series of sounds." By reading Helmholtz' chapter upon Scales and Temperaments we can trace the gradual evolution of the scale as adopted by modern musicians and their final agreement upon what is called equal temperament, a slight conventionalizing of the tones of nature. This may be analogous to the conflicting ideas regarding color standards.

By referring to a treatise on harmony by Alfred Day we find this extract: "The discovery of generated harmonics had been held as belonging to science and not pertaining to art. Composers had employed what may be classed as natural in distinction from arbitrary combinations, but each only on the prompting of his genius with the justification of their effect.

In another place Mr. Day says: "Empirical rules drawn from the tentative practices of great musicians were from time to time enunciated, but no theory, till that of the generation of harmonics proved the natural principles upon which unknowingly masters have wrought, nor distinguished between these ingenius artifices whereby in former times musical etymology and syntax were regulated."

In a similar strain J. Clerk Maxwell remarks in his Harmonic Analysis: "It would not be devoid of interest had we oppor-

tunity, to trace the analogy between these mathematical and mechanical methods of harmonic analysis and the dynamical processes which go on when a ray of light is analyzed into its simple vibrations by a prism, when a particular overtone is separated from a complex tone by a resonator and when the enormously complicated sound wave of an orchestra or even the discordant clamors of a crowd are interpreted into intelligible music of language by the attentive listener armed with the harp of three thousand strings, the resonance of which as it hangs in the ear, discriminates the multifold components of the aerial ocean."

The necessity and paramount advantage of scientific standards as the basis of all musical instruction and musical excellence is summed up by Sir George Grove in this way: "It may seem an anomaly that art excellence should be tested by academical regulations since by some they are supposed to soar above rule, but rise as it may, to be art it must be founded on principle and in its working to-day it oversteps its limits of yesterday, it is forever unfolding new exemplifications of those natural laws upon which it is founded and the greatest artist is he who can most deeply prove and is thus best able to apply the phenomena upon these grounds, then it is not beyond the province of the school men to test and declare the qualifications of the artist."

Passing from the realm of music to that of chemistry it would be possible to trace an advance from chaotic beginnings to an exact science which presents a more emphatic evolution than the one already noted. Chemistry has its origin in the labors of the alchemists who flourished in Europe from A. D. 800-1300. The Arabians who were the first people to make advances in the study aimed to change base metals into gold. Basil Valentine held about the fourteenth century that metals were composed of mercury, sulphur and salt, although these substances were not the same as the common bodies which now bear their names. Lemery 1645-1715 maintained that there were five chemical elements, water and earth being the passive

elements and mercury or spirit, sulphur or oil and salt the active ones. Beecher, 1635-1681 and Stahl, 1660-1734, undertook to explain the change following from combustion.

Previous to the time when the celebrated French chemist Lavoisier, began his investigations, confusion and difference of opinion regarding the quantitative relations of chemistry reigned supreme and it was not until he brought his great powers to bear upon the subject that light was evoked from the darkness and the true and simple nature of the phenomena was rendered evident. His experiments overthrew the old phlogiston idea of combustion and led to the complete understanding of oxydation. In 1803 Dalton published the first table of atomic weights and in 1818 Berzelius fully established the fact that the elementary bodies combine in certain given proportions by weight or in multiples of their proportions.

Of course as long as confusion prevailed concerning the elements of chemistry it could have no nomenclature worthy of the name. Lavoisier and his colleagues pursued a definite and scientific scheme of chemical nomenclature which has since been adopted and used with slight variations throughout the scientific world.

In this nomenclature the old common names of the elements have in most cases been retained. The names of recently discovered metals end in ium as sodium and barium. Those of the nonmetallic elements end in ine as chlorine and bromine. The names of the other elements end in on as carbon. Oxyde is applied to compounds as in oxygen.

Turning for a moment from chemistry to drawing we notice that this latter pursuit, which is very closely allied to color, was formerly regarded as a mysterious science known only to a limited class called artists who could have from the nature of the case, but a limited number of pupils. Nothing however would seem to more pointedly mark the advance of modern public school education than the progress which the children of to-day are everywhere making in this popular branch. But while the results secured put to shame the decorative drawing

which was so much lauded in the schools ten and fifteen years ago, the reason is found in the fact that these results spring from the rudimentary principles of science, which must be mastered early in the course. The boy who begins form study under competent teachers on entering school and supplements it with a course of paper cutting and folding followed by drawing is prepared to give a much better explanation of what he is doing and why he does it than the decorative artist who has had no such training. To a student of such matters the recent evolution in drawing is very evident.

And what shall we say of literature? Only a few of us can be born poets and according to the ancient maxim none of us can become poets by study. But with proper instruction all of us can learn the scientific construction of language, by the use of which the most gifted poets can alone express their ideas. There is, we maintain, a science of literature, which underlies its most brilliant effusions, a science which is most readily perceived when we come to compare the crude efforts of a Chaucer with the finished productions of an Emerson or a Howells.

Modern teachers do not regard that study of language the best, which in the beginning committed to memory all the scientific rules of language. They prefer to first give the pupils good samples of language and after they have become familiar with correct results they are taught the rules on which these results rest.

As in language so in color, there are certain scientific facts which must be learned, just as the rules of language are learned. When we give the pupils good examples in color we must be careful that those examples are based on some science by which they can again be produced at pleasure, and by which standards they can be tested so as to ascertain whether or not they are correct.

Perhaps we cannot finish this chapter in any better way than to quote from the preface to the Theory of color by Von Bezold, published by L. Prang & Co., Boston, where the author says: "The opinion is frequently met with, that the most

glorious creations of the fine arts owe their origin almost exclusively to an inborn talent, which has been developed by long-continued practice; while on the other hand it is believed that scientific investigations into questions of art are of but small value to true genius, and that, at the very best, they can only help mediocrity to attain to achievements of questioned merit.

Curiously enough, history teaches us that the most prominent artists did not share this opinion. The great heroes of art, those men whose work betray a master's hand in every line, exerted themselves most zealously to replace purely instinctive effort by conscious activity and to inquire into the causes which underlie all successful creative production. Although nothing was more foreign to them than the idea that technical skill must be looked upon as the ultimate aim of their studies, they nevertheless neglected nothing which appeared to be calculated to make them thorough masters of their craft and for the purpose of reaching this aim, they were quite as earnest in devoting themselves to scientific studies, as they were well assured that the perfect control of all outward aids is absolutely necessary if the emancipated intellect is to be enabled to soar to the highest realms of art without being hindered by petty limitations."

CHAPTER VI.

HOW TO UTILIZE THE SPECTRUM AS A STANDARD OF COLOR.

IF we admit that the spectrum is the only source from which we can derive standards of color and on which to base a scientific nomenclature of colors, it becomes necessary to, compare pigments, that is, material colored surfaces, with the spectrum.

To make any experiments with a solar spectrum we must first secure the spectrum and not only a spectrum but the best that is possible within the reasonable limits of common physical apparatus. The long-established method among scientists of getting a spectrum has been by the use of a heliostat, that is an instrument having such an arrangement of mirror and clock-work as will throw a beam of light horizontally into a darkened room and keep it constantly in the same place for a considerable time. But this instrument is somewhat expensive and for ordinary experiments in color a solar lantern or porte lumiere serves a good purpose. Having a solar lantern of the ordinary construction, remove the lenses and take the beam of sunlight from the mirror directly through a slit occupying the place usually devoted to the lantern-slide.

In front of this vertical slit place a prism of glass, or what is better, a glass bottle made in the shape of a prism containing bisulphide of carbon, with its edges vertical. This will project a horizontal spectrum into the room, which for the best results should be made as dark as possible, and by locating the spectrum on a white surface it can be conveniently studied. Having secured the spectrum, the task which we have in hand is the comparison of a line of colored papers to see how they will match the colors of the spectrum. For example, having a

number of red papers, we must determine which of them is the nearest match to the reddest red in the spectrum but in doing this we must not expect that any papers or other material that can be manufactured will equal the brilliancy of the spectrum. In the case of the red, having first decided by the mutual consent of a large number of competent judges precisely in which part of the spectrum the purest or reddest red is located, we must determine whether any piece of red paper that may enter into the comparison is a more orange red or a more violet red than the spectrum standard, or if it is a lighter red or a darker red.

We can readily imagine that in making such comparisons there must be a decided lack of agreement at the starting-point among those who are called to sit in judgment on the case. When eyes of various degrees of education, eyes with no education and eyes endowed with natural color-perceptions are together employed in such a matter entire harmony of opinion is hardly to be expected. Nevertheless, the experience of those who have experimented along this line of scientific investigation proves that with a wide range in the occupations of the experimenters, who included both men and women, there has been a wonderful unanimity of agreement regarding the spectrum standards, that is, the precise location of the most intense reds, greens, etc., in the spectrum, and also regarding the matching of colored papers with those standards.

Indeed, this alleged difficulty in securing a verdict which shall be practically unanimous regarding standards and comparisons can be set aside as of little importance, because while the first standards which have been selected may possibly, by mutual consent and as the result of greater experience, be modified, no change materially affecting the general principles entering into color combinations is likely to be required.

Knowing that it had long been laid down in the books that the solar spectrum furnishes a perfect standard of the six colors, certain students of this color question on its artistic, scientific and practical sides resolved, some months since, to appeal to old Sol himself for such a standard as their fellow

students should be willing to accept and adopt. The results of the experiments which they made as a means of investigating this problem have proved, on the whole, very satisfactory to themselves, and for that reason it is proposed to give a brief account of them here.

It has been generally stated that if a piece of colored paper is held in the spectrum partially covering the width of the band the correspondence or difference in color will at once be determined. In other words, that if the paper is a true match the spectrum color will show the same color on the sample as on the white screen, and if it is not a true match a difference will be easily detected. The first part of this statement can not be questioned, but to the ordinary eye the latter part is not true in practice, unless there is a decided difference in the colors.

The above very simple test failing, we were obliged to adopt some other method of deciding when we had secured a true match to the spectrum. The principle of the spectrum and method of producing it have been explained in Chapter II. In order that the teacher may understand the nature of the experiments to be described we will assume that we have the darkened room with a porte lumiere in our window and have our spectrum thrown on a white screen, at a convenient point in the room. Now if we could see the color of our paper sample in the dark room the problem of how to make the comparison would be very simple, but this is, of course, impossible without some special apparatus. To secure this desired result we placed a second porte lumiere in another window and with it projected another beam of light across the room. At a convenient point this beam was intercepted by a hand-mirror and reflected on the screen, just beneath the spectrum. Now holding our sample of paper in the light of this second beam we find that it is illuminated with the same brilliancy as the spectrum, both being reflected sunlight, so that a comparison can be readily made. As a color can be judged more correctly when seen alone, separated from other colors, we made a

secondary screen of card-board and cut in it a hole or slot as long as the breadth of the spectrum-band and about half an inch wide. With this screen placed in front of the first screen the entire spectrum may be shut off, except any small section which is allowed to pass through the slot on to the rear screen, where it can be examined isolated from the other colors of the spectrum. If we place another screen of card-board having a small hole in it in front of the hand-mirror and throw the beam of light through the hole a much better illumination of the sample will be obtained than is otherwise possible.

To any one who has seen a perfect spectrum under favorable conditions it is useless to say that the disappointment experienced in the comparison must at first be very decided. But after a little practice one becomes accustomed to the difference in brilliancy and is able to judge which of all the samples tried is the closest imitation of the spectrum, for pigments are at best only imitations of the spectrum colors. We are able to comprehend this fact while examining the most celebrated paintings where the artist has attempted to represent a winter or spring sunset-sky, in which the green, the orange, the yellow and the blue are blended in such softness and yet such purity and brilliancy as to always entrance the intelligent lover of color in nature; but where the efforts of the best artists are exceedingly tame in coloring when they are compared with nature.

In our first experiments the water and oil colors were carried to a room adjoining the dark room together with a great variety of colored papers and other materials, with the intention of making colors on the spot to match the spectrum. But it was early discovered that in every color closer matches were found in the colored papers than could be made with either the water or oil colors. Although this result was a surprise at the time, it appeared to be a natural consequence on further reflection, because water colors are less modified by the medium with which they are mixed than are colors prepared in oil, and the papers are coated with the purest form of water colors, with the least possible mixture of gum necessary to hold them to the surface.

In making our experiments to determine the six standard colors of the spectrum we have adopted the method described above because it involves the simplest possible apparatus which is available in any high school, to say the least, and which we hope before long will be found in every grammar school. The use of this apparatus allows a considerable number of people to assist in making the comparisons desired and is especially recommended because the average opinion of several persons secured from a variety of tests is of more value than the verdict of a smaller number resulting from investigations made singly and at different times, as is required in the use of the spectroscope. But with all the diversities of eyes and the great difficulties attending the production of desired hues for commercial uses, it is not even suggested that the exact or best possible matches of the six standard colors desired for a starting point have been found. All these things must be changed and modified by time, experience and increased interest in the subject. When a set of material standards shall have been definitely established by common consent it will be a very simple matter to locate them in the spectrum by reference to the well-known fixed lines of the solar light and thus establish absolutely for all time these standards for use in work which pertains to color and in whatever shall be written about color.

CHAPTER VII.

THE USE OF THE ROTATING DISKS.

HAVING secured from the spectrum our six standard colors by the combination of which the other hues of the spectrum may be closely imitated and from which with black and white a very large number of other colors can be made by combinations, we must look for some comparatively simple method by which we may form those combinations and be able to measure the proportions used of each color, which it is impossible to do with pigments.

The spectrum colors may be reunited by means of lenses and mirrors and the required combinations accurately secured. These experiments, however, must be performed in a dark room and with considerable care, and, fortunately for primary education, we have in a device generally known as the Maxwell rotating disks a much simpler and more practical expedient than the use of the lenses. It is based on the persistence of vision as familiarly seen in the rapid revolving of the lighted end of a stick forming a complete circle of light, or as differently shown in the well-known toy and philosophical instrument called the Zoetrope.

If the surface of a circle of white card-board is divided into sections by radial lines and every alternate section so formed is painted black, the surface of this disk when it is rapidly rotated will assume a uniform neutral-gray color, showing that the black and the white sectors are blended in the eye by their rapid successive presentation. If red is substituted for white in the sectors, the combination becomes a dark shade of red or a dark brown, according to the relative proportions of black and red.

The fact that these results could be secured has long been

known and the device of the rotating disks used as a curious experiment, but its practical utility has in recent years been greatly enhanced by a very simple improvement made by J. Clerk Maxwell. He merely cut a slit from the circumference to the center of the disk, and thus was able to combine on one spindle of rotation two or more disks of different colors in any desired proportion. As these experiments with the rotating disks are interesting and valuable to children the various combinations that can be made with them are fully explained in the following paragraphs, so that with the rotating spindle any teacher can readily perform the experiments before a class. In Fig. 1 disks so combined are represented attached to a revolving spindle, such as is already in general use in school laboratories and should be included in the outfit of every school-building.

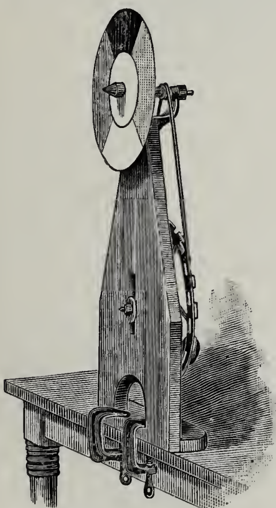


Fig. 1.

It has been determined that in order to secure a perfect combination of colors with rotating disks there must be a speed of at least fifty revolutions to the second. With slower speed there will be a dazzling effect, very unpleasant to the eyes, and no well-defined color. A little mathematics will determine the speed possible with any apparatus, and unless at least the above speed is secured no satisfactory results can be obtained in color work.

Fig. 2 represents in perspective two disks partially put together, showing clearly the method of uniting them.

Fig. 3 is a face view of the disks, with their centers coinciding, ready to be placed on the rotating spindle. Suppose these two disks to be green and yellow respectively, then by rotation the larger surface of yellow is modified by combining

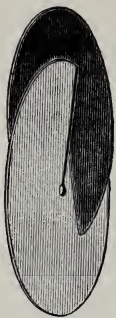


FIG. 2.

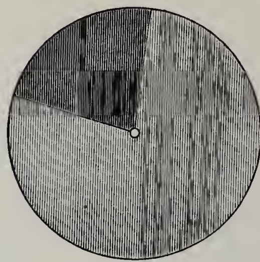


FIG. 3.

with it the smaller quantity of green, forming a green-yellow, or a greenish yellow. The standard green and the standard yellow being fixed and accepted, this same combination will always produce the same hue, and if we can record the exact amount of green and yellow it can at any future time be reproduced.

In Fig. 4 is shown the same disks adjusted in the same proportions and with them a third disk not slitted and a trifle larger. The outer edge of this third disk is divided into 100 equal parts, so that the exact proportions used for any given color can be determined at a glance, as in this case 22 green and 78 yellow. If a tint of any standard color is required a disk of that color is combined with a white disk, or if a shade is wanted a black disk is used with the color, and with these three all shades and tints can be produced.

By the various combinations of the six disks, red, orange, yellow, green, blue, and violet with each other in twos, all the hues of the spectrum may be closely imitated, and in addition a line of red violets and violet reds between the violet and the red, thus uniting the two ends of the spectrum.

Thus far we have considered the combination of the disks in pairs merely. But three or more disks may be joined, as shown in perspective in Fig. 5.

A simple application of the trio of disks is seen in the production of shades and tints of hues intermediate between the

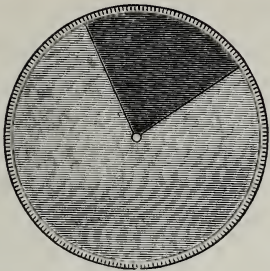


FIG. 4.

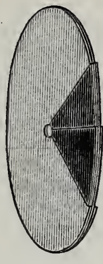


FIG. 5.

standards, as for illustration, if we wish to obtain a shade of the green-yellow already mentioned we add a black disk to the green and yellow disks. Fig. 6 shows two colored disks with a small graduated scale, which is sometimes more convenient to use than the large one when absolute accuracy is not required.

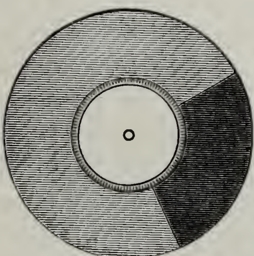


FIG. 6.

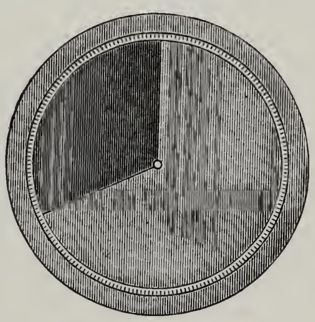


FIG. 7.

In forming combinations of two colors it is often desirable to have a constant comparison of the new color with one of the standards, and Fig. 7 shows two color disks, as, for example, the green and the yellow with the large graduated scale, as in Fig. 4, and in addition a large yellow disk. In rotation the result will be a ring of yellow surrounding a disk of green yellow and separated from it by the graduated scale.

Fig. 8 shows the same thing, with the addition of a small disk of green at the center, thus placing the new hue between the two colors of which it is composed.

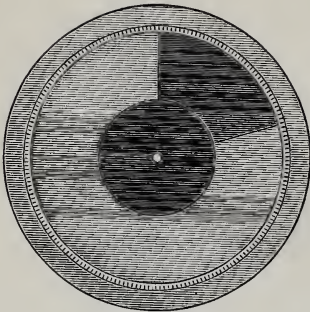


Fig. 8

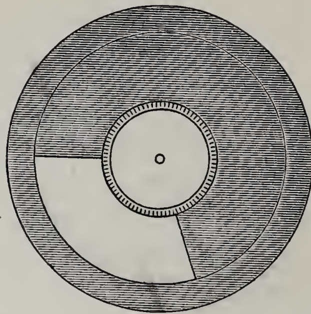


Fig. 9.

Fig. 9 represents the production of a tint of a color with a ring of the color outside and the small graduated disk used as a white disk at the center, thus securing a comparison of the tint with both the colored and the white disk. For example, to get a tint of yellow use yellow and white disks, with the large yellow disk at the back and the small graduated white disk at the center, thus giving a tint of yellow between full yellow on the outside and white at the center.

Fig. 10 is given more as an illustration of the curious possibilities of the disks than because it is necessary in explanation of any new principle. Beginning at the center we have the white graduated scale, which gives us a white center. Next we have a white and a black disk, the proportional combination of which is determined by the small scale. Back of these

Fig. 10.

are three disks combined, as, for example, red, yellow and blue, or, of course, any other three colors; then the large scale and back of all a large white disk. We use this combination to determine the tone of a color as established by the gray made from the black and white. Having set any two or three disks so as to produce a desired hue, with the white and

black set at random, the whole is rotated, and thus the hue produced is compared with the gray made by the black and white. If the hue seems darker than the gray the black and white disks are adjusted till the gray and the hue of the combined disks seem to be of the same tone. The tone of that hue is then established and may be recorded mathematically, to be referred to at any time and reproduced at will.

A careful study of these representative combinations of disks can hardly fail to convey the whole idea of the Maxwell disks and to suggest numerous possibilities respecting combinations. The Maxwell disks and many other simple devices for experiments in color are fully explained by Prof. Rood in his book elsewhere noticed.

In consequence of the old theory of color based on the three primaries and their combinations to produce orange, green and purple, the orange, green and violet of the spectrum are constantly referred to as secondaries, and hence the combinations of these in pairs are called tertiaries. While it is not well to perpetuate in the minds of the children these names, it may possibly be convenient to use them occasionally to designate the groups of colors which they represent, until a better nomenclature has been adopted and familiarized. The terms olive, citrine and russet, for instance, are exceedingly indefinite, as each covers such a wide range of hues, and they are dependant to such a degree on the chemical nature of the pigments combined to make them.

The various combinations of purple and green have been called olives. The term russet indicates the combination of the purple and orange in varied proportions, and citrine is the name applied to the varied hues composed of green and orange when produced by the union of various pigments. With the orange, green and violet disks a beautiful series of hues is produced, which can be definitely named and recorded, although not exactly like all the hues that can be made from the combinations of the various pigments classed as orange, green and purple. With the standard blue and red a line of purples can

be made and one of them may be used for a purple disk for forming combinations with the orange and the green, to approximate the olives and russets of the pigment colors.

In using the disks it will be noted at the outset that the effects of combining colors by this means are somewhat different from those which are produced by the combination of pigments. The most apparent illustration of this fact is seen in the combination of the blue and yellow, which in pigments gives green, but with the disks or the mixture of light gives gray. It is also seen in the use of the white disk to produce tints. Here the effects appear very much as they would if the disk contained a little red, and the phenomenon has been explained by the supposition that sunlight is slightly reddish.

Notwithstanding this difference between the mixture of light and pigments the combinations with the disks offer us the great advantage over the other method, inasmuch as by them we may determine the exact proportions of each color entering into any combination, and thus are able to make a record from which we may reproduce those proportions at pleasure.

If we borrow our standards from the sun and with them make combinations we have results which are the same in Africa as in America, and will be the same a hundred years hence as they are to-day.

It is on a series of facts like these we base our scheme of primary color education. Having established standards for the six colors, red, orange, yellow, green, blue and violet, selected from the spectrum, and having made rotating disks corresponding to those standards, our next step has been to manufacture a limited and well-arranged line of colored papers based on these standards, to be used for educational purposes in connection with the rotating disks. We also propose to give to these disks and papers definite names based on the proportion in which the original colors are combined.

Whenever the disks are in use before a class, no matter how large, there need be no fear of want of attention on the part of any pupil. But it is always necessary to place the rotating

machine where the best possible light will fall on the face of the disks and facing the pupils, which in the ordinary school-room will be on the teacher's table.

It is very desirable that the light should be directly from the sky and not reflected from a red brick wall of adjoining buildings or from green foliage, as all such surroundings always seriously affect any class-study of color far more than is usually realized.

Doubtless the artist and the colorist will object that the proportions shown by the wheel bear no relation to the proportions in which pigments must be mixed to produce the same results, and that similar pigments do not give the same colors in whatever proportions they may be mixed. While it is impossible to deny these statements, we do not admit that the objections raised are pertinent to the argument, but maintain that it is proper to entirely divorce for the time the teaching of color with a definite nomenclature of colors from the making of the colors with pigments or the naming of them from the pigments.

We anticipate that the artist may not be willing to accept the new departure proposed in these pages, for fear that he will find it impossible to make all the colors in nature or in art from the six spectrum standards by the use of the wheel, but no new system is ever perfect in the beginning, and all that the authors of this scheme ask is a fair trial and honest investigation. Suggestions as to improvements on the system or corrections of errors must be welcomed and honestly considered by all who are sincerely studying this color question. We believe that a little practice will demonstrate that for educational purposes the line of papers produced by this scheme is ample for all primary work, and that any one, either an adult or child, having this set of standards and their nomenclature well in the eye and mind, will be better equipped to go further in art education than has been possible by any system of color education ever before advanced, if forsooth it can be claimed that there has ever been a system worthy of the name.

CHAPTER VIII.

THE DEMAND FOR A DEFINITE COLOR NOMENCLATURE.

ALTHOUGH frequent reference has already been made to this matter its importance demands a separate chapter. If the desirable and necessary combinations of the wheel become established this whole color scheme must have a nomenclature fitted to it, something that shall come to be as well understood and generally accepted as the equivalents of chemistry.

The lack of a fixed and scientific standard of color among artists causes many misstatements by the best writers. A prominent English author says: "Although the science of optics of late years has made great advances, it is not yet possible to deduce from it any certain rules to determine the relative proportions which colors in juxtaposition must bear to each other, in order to produce perfect harmony. A knowledge of the proportions can only be acquired by the cultivation of the artist's taste, and probably varies with the peculiar quality of the perceptive faculties of each individual." This statement is true only because there have been no standards to which writers and investigators could definitely refer. Rules are deduced by a multiplication and analysis of recorded facts. No facts of color have been capable of record, because there has been no accepted standard colors and no nomenclature based on standards by which it could be stated that such and such colors harmonize with each other.

The same author subsequently remarks: "Some difficulty in naming colors may arise, not from any imperfection in the visual organs, but from the want of a clear and distinct nomenclature; thus we often allow ourselves to designate as yellow

those colors which are mixtures of yellow and red or of yellow and blue in different proportions. With the view, then, of avoiding confusion, as well as unnecessarily taxing the memory of the student, we must be careful to render the names of the colors and their compounds as simple and accurate as possible."

Again this writer adds: "In explaining the terms used by artists great difficulties present themselves, which arise not so much from deficiency of information as from the remarkable irregularity and indefinite character of those various terms as they are employed both by artists and amateurs."

M. Chevreul, in his very valuable work, "The Laws of the Contrasts of Color," indicates the want he felt for some definite nomenclature of color by an attempt to formulate one by designating six reds by numbers, etc., as follows:—

a	Red	*c*	Orange	*e*	Yellow
1	Red	1	Orange	1	Yellow
2	Red	2	Orange	2	Yellow
3	Red	3	Orange	3	Yellow
4	Red	4	Orange	4	Yellow
5	Red	5	Orange	5	Yellow
b	Red-orange	*d*	Orange-yellow	*f*	Yellow-green
1	Red-orange	1	Orange-yellow	1	Yellow-green
2	Red-orange	2	Orange-yellow	2	Yellow-green
3	Red-orange	3	Orange-yellow	3	Yellow-green
4	Red-orange	4	Orange-yellow	4	Yellow-green
5	Red-orange	5	Orange-yellow	5	Yellow-green

But he adds: "I attach no importance to this nomenclature. I employ it only as the simplest to distinguish the seventy-two scales just described. The number may be increased indefinitely by inserting as many as we choose between the above." The trouble with his scheme was that it lacked any standard or definite measurement by which any one of the hues indicated can be produced to-day. Had this eminent colorist and scientist established six definite colors in the spectrum, which we could determine as his six colors, and from them given us seventy-two well-defined hues, how greatly advanced would be the color education of our time compared with its present condition!

While treating the same subject Von Bezold says: "Nevertheless, the works of prominent colorists show a very consistent application of certain expedients, and it does not admit of a doubt that these masters had formulated, at least for their own use, fixed systems for the treatment and application of color, which may perhaps have been handed down as traditions to their personal scholars, but which others can only reconstruct with difficulty from their works. Such systems cannot become common property, unless it should be possible to give them a scientific expression."

Much might be said in criticism and even ridicule of the grotesque confusion which prevails in regard to naming colors in the commercial world, as well as among authors who call themselves scientists. There is no limit to the flights undertaken by milliners, dry-goods men and paint manufacturers in their attempts to eclipse each other's nomenclature. To illustrate their soaring fancies we may be excused from quoting literally from the advertising columns of a current daily newspaper:—

"Some of the colors are beautiful. Words can hardly hint

bright golden yellow
tender spring-like stem greens
delicate blue-gray shades
rosy lilacs and pale lavenders
rich new egg-plant purple

and all the old favorites, including clear rose pink, true blue, china blue and pale baby blue.

All sorts of yellow will be good, such as

Creme, which means ivory white
Gluten, deep cream
Mais, corn color
Ebenier, deeper shade of corn
Ble d'or, still deeper
Toreador, warm yellow
Paille, straw color
Bonton d' or, buttercup
Vieille paille, old straw

in fact all yellows going down as deep as the old color called Mandarin and branching into terra cotta, but this latter will be

used gingerly; next to yellow comes sky blue, which is the rage just now in Paris but may not last. Then comes the Eiffel range of shades,

Aurore, a pinkish lava
Eiffel, a reddish brown
Marronier, deeper vieux rose.

The newest color most talked up is Aubergine—what you call egg plant. These are shown in velvet pansies and orchids to be worn both on black and acorn-tinted hats and bonnets.

Scabiense, a deep shade of heliotrope
Prune, still deeper

are also in this series; outside these are some reds, pinks and beiges.

Coquelicot, a poppy red
Cardinal, a deeper red
Poupre, intense red
Azalee, deep salmon pink
Ceres, fawn color
Colombe, perfect shade of dove
Beige, a wood shade

No confidence whatever in grays, greens or browns."

That the commercial people have some excuse for confusing themselves and the public while indulging in such flights of language may be conceded, because they can only be judged by commercial rules and influenced by commercial considerations. But what shall we say of the scientists who are struggling with the attempt to adequately and comprehensively name the many colors which they and the rest of mankind have occasion to use? According to their own confession they have not fared well in the past, for Von Bezold says in his "Theory of Color": "The names of colors, as usually employed, have so little to do with the scientific, technical aspects of the subject that we are in reality dealing with the peculiarities of language." Recognizing the painful lack of a satisfactory color nomenclature and being particularly interested in ornithology, Robert Ridgway curator in the United States national museum, wrote a book a few years ago for the sake of establishing "a nomenclature which shall fix a standard for the numerous hues, tints and shades which are currently adopted,

and now form a part of the language of descriptive natural history." In the preface he assures us that he has spared no pains to accomplish his object, and admits that certain of the names adopted may not be entirely satisfactory, but puts in the plea that when those which are exclusively pertinent or otherwise satisfactory are not at hand they must be looked up or invented. In his opening article on "The Principles of Color" Mr. Ridgway states the case as follows: "The popular nomenclature of colors has of late years, especially since the introduction of aniline dyes and pigments, become involved in almost chaotic confusion through a coinage of a multitude of new names, many of them synonymous, and still more of them vague or variable in their meaning. These new names are far too numerous to be of any practical utility, even were each one identifiable with a particular fixed tint. Many of them are invented at the caprice of the dyer or manufacturer of fabrics, and are as capricious in their meaning as in their origin, among them being such fanciful names as "Zulu," "Crushed Strawberry," "Baby Blue," "Woodbine-berry," "Night Green," etc., besides such nonsensical names as "Ashes of Roses," "Elephants' Breath," "Peacock Blue," "Calves' Liver," and "Iron Rust Red." An inspection of the sample-books of manufacturers of various fancy-goods (such as embroidery silks and crewels) is sufficient to show the absolute want of system or classification which prevails, thus rendering these names peculiarly unavailing for the purposes of science, where absolute fixity of the nomenclature is even more necessary than its simplification."

After treating his subject exhaustively this same author presents his readers with ten pages of color plates illustrating the best collection of colors which he has to offer. The list includes about two hundred, and here are some of the names which Mr. Ridgway uses: Mouse Gray; Slate Black; Smoke Gray; Pearl Gray; Seal Brown; Clove Brown; Walnut Brown; Mummy Brown; Fawn Color; Isabella Color; Hair Brown; Ecru Drab; Claret Brown; Liver Brown; Dragons' Blood Red;

Bay; Salmon Buff; Vivaceous Pink; Gallstone Yellow; Indian Yellow; Wax Yellow; Maize Yellow; Lake Red; Poppy Red; Flame Scarlet; Chinese Orange; Peach Blossoms Pink; Prune Purple; Indian Purple; Phlox Purple; Wine Purple; Mauve; Berlin Blue; Paris Blue; Flax Flower Blue; Nile Blue; Bottle Green; Apple Green; Oil Green.

After reading the list, of which the above is but a small part, one is tempted to inquire of the learned author whether he really believes that "for the purpose of science absolute fixity of the nomenclature is even more necessary than its simplification"?

While treating this matter of nomenclature we wish the reader to understand that we do not assume to formulate any unalterable scheme of nomenclature, but to merely suggest a collection of symbols based on a scientific analysis of light and apply them to a line of colored papers for primary education, thereby putting our ideas to a positive test. By so doing we expect to draw out criticism, which will be gladly received when accompanied by improvement. Criticism, however, without suggested improvement is useless, as it does not advance reform. We do aim to establish a nomenclature which shall convey a definite impression regarding the composition of colors. For instance, we will use the initials of the colors to represent the six standard spectrum colors: R for red, O for orange, Y for yellow, G for green, B for blue, V for violet. For white we use W, but while we should in the ordinary sequence use B for black that letter has already been employed to designate blue, so we must adopt some other symbol and we choose the Latin word, Niger, for black, already found in chemistry, and use N for black. Thus in a general way a very simple nomenclature at once suggests itself. For all the tints W precedes the letter symbol of the color, as WR for the tints of red, WO for orange tints, and so on. For shades the letters are NR, NO, NY, etc. For intermediate hues the two color symbols are combined, as, for example, the hues between red and orange, R and O, are combined, and so on through the spec-

trum. The same principle is, of course, followed in the combinations of the old secondaries, and therefore all the olives as generally accepted are represented by VG, Russets by VO and citrines by GO, or if instead of the violet of the spectrum we use a purple, we have PG, PO and GO.

Here we also have the advantage of being able to be definite, when we so desire, which is impossible in the old scheme of primaries, secondaries and tertiaries. For example, in a tint of red we may have WR 5743, which indicates that for this tint we take 57 parts of white and 43 parts of the standard red as determined by the Maxwell disks when rotated on the wheel. Or for a deeper tint we have WR 3367, i. e., white 33 parts and red 67 parts. For a shade of red we may have NR 5545, or NR 7525. If it is an intermediate hue we wish to indicate we may have for a greenish-yellow tint WYG 254035, which indicates that we have white 25, yellow 40, green 35; or for a shade of same color we can take NYG 383230, i. e., black 38, yellow 32, green 30 parts. If in the disks used we secure the whitest white and the blackest black it is possible to make, and the standards of color have been accepted, although the black and the colored disks reflect a small percentage of white light and the white disk some gray, yet we have a standard and a nomenclature practically correct. In this connection the reader is referred to our scheme of colored papers described in Chapter X.

CHAPTER IX.

THE PROPER COMBINATION OF COLORS.

THE impossibility of formulating any very definite rules by which a person unskilled in the combination of colors can properly use them to produce artistic effects seems to be generally accepted. This proves, however, that something is wrong, because in all other lines of scientific research a student may avoid absolute mistakes during his progress by obeying definite laws, although he may not achieve the highest degree of success. There are certain general principles which the student who is earnestly seeking to make artistic color combinations ought to be able to master from printed instructions in this mysterious art.

The subject of simultaneous contrasts seems to lie at the foundation of the harmonies of color combinations. If a disk of green paper, two inches in diameter, is placed on a white or gray wall and the eye intently fixed on it for a time and then turned a little so as to rest on the plain part of the wall, a disk of red tint will be plainly seen. This red tint is the simultaneous or complementary color to the green, although in this experiment it may be said to be only a ghost of the pure color. The complementary color is the one which must be added to a given color in order to produce white or gray. In general a color approximates a harmonious contrast with its true complementary, but this rule cannot always be followed with the best effect, and rarely with the so-called complementaries as made with the three pigments, red, yellow and blue. For example, in the case of full or saturated red and green, the contrast is so hard as not to be pleasing, red and blue often being better, while some combinations in tints and shades of red and green are pleasing.

In considering this subject it must always be remembered that the exceptions are so frequent as to make it very difficult to utilize these rules. All rules to be of any value must result from the classifying, compilation and assorting of intelligent and carefully recorded experiments. That the experiments which have been made in combining colors are numerous and that they were very carefully conducted by eminent scientists and artists none will deny. It is also evident that through these experiments the few individuals concerned reached a high degree of ability in the art, but alas, they had no means of recording their knowledge so as to hand it down to succeeding generations. If we had to-day a record of a hundred or five hundred pairs of colors and triads of colors which were pronounced by the universal consent of generations of artists as pleasing or unsatisfactory in combination we could readily formulate certain definite rules. It is needless to add that such a scheme of rules would make an exceedingly valuable foundation for elementary education in color.

The statement is made that if the spectrum were supplemented with the violet reds and the red violets at either the violet or red end and then formed into a circle the colors opposite each other would approximately be complementary to each other. In other words, if half the length of the spectrum should be taken between the points of a pair of spacing compasses when one point is at a given color the other point would touch its complementary color. Such statements are in a measure true, and are useful in forming a general key to the complementary colors. Thus the reds are opposite the greens. As the red approaches the violet the green approaches the yellow, and as the red approaches the orange the green comes near the blue. But having determined all the complementary colors and hues we are seemingly only a little nearer a definite knowledge of the best harmonies than we were before, because, with our present knowledge, there appear to be no laws that always hold good. It follows that if such laws cannot at present be found we must rely upon a multiplicity of separate

facts from which we may hope in time to formulate rules of practical value.

In general the simple complementaries are stated as red and green, orange-red and blue-green, orange and blue, orange-yellow and violet-blue, yellow and violet, greenish yellow and reddish violet. But while in the full colors some of these contrasts are pleasing the others are too hard and prove tiresome to the eyes. According to some authorities we have such combinations as the following given as complementaries :—

Vermilion and green blue.	Greenish yellow and French blue.
Orange and greenish blue.	More greenish yellow and violet.
Yellow and blue.	Green and purple.

Barnard gives these accidental colors with colored wafers on a white ground :—

Red and bluish green.	Indigo and orange yellow.
Orange and blue.	Violet and yellow green.
Yellow and indigo.	Black and white.
Green and orange red.	White and black.

Chevreul lays down the following directions concerning Harmonies of Contrast :—

Red and yellow better than red and orange.
Red and blue better than red and violet.
Yellow and red better than yellow and orange.
Yellow and blue better than yellow and green.
Blue and red better than blue and violet.
Blue and yellow better than blue and green.
Red and violet better than blue and violet.
Yellow and orange better than red and orange.
Yellow and green better than blue and green.

The following so-called complementaries are taken from various published authorities :—

Purple and green.	Orange and ultramarine.
Carmine and bluish green.	Yellow and bluish violet.

Vermilion and turquoise blue.	Yellowish green and purplish violet.
Red and green.	Red and bluish green.
Orange and blue.	Orange and Cyan-blue (a greenish blue.)
Greenish yellow and violet.	
Indigo and orange yellow.	Yellow and ultramarine blue.
Red and green blue.	Green and purple.
Carmine and blue green.	Greenish yellow and French blue.
Vermilion and green blue.	
Orange and greenish blue.	Yellowish green and violet.
Yellow and blue.	

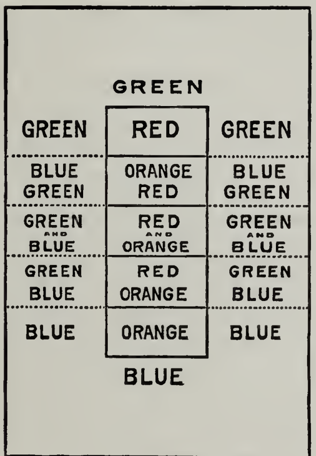
All the above may be proper complementaries, but as long as no reader knows what colors the authors had in mind and represented by the names given, they are of no value, except in the most general sense. Just how much "bluish," "greenish" or "yellowish" means no one can say, neither can any one determine with the least scientific or artistic accuracy what is the color of vermilion or carmine or French blue, as they all depend on the process of manufacture and the mediums with which they are mixed.

Also in purple who shall say with any definiteness which of the whole range from red to blue is intended? And as for the general term "violet," unless the spectrum violet is accepted, the range is almost as great.

The harmonious effect of old color combinations, and of the combinations made by the natives of semi-civilized countries is not due to their superior tastes and knowledge of colors, but to the fading of the colors and to their inferior color pigments. We find that in certain color combinations, as for example red and green, each color is rendered more brilliant by the union, and the chief objection to this brightened brilliancy which to the children is most attractive, is the hardness or harshness caused by the combination. But if both colors are reduced in brilliancy either by the addition of white light or by

the want of light i. e., the admixture of gray, as was the case in the ancient pigments, the contrast is pleasing. This is a result at which the ancient color mixers arrived unconsciously.

The principle governing the combinations of hues, based on the phenomena of simultaneous contrasts is illustrated in the accompanying diagram.



By the use of water colors the pupils may be led to see this principle for themselves. The ends of the inside oblong should be painted with any two of the standard colors juxtaposed in the spectrum, as red and orange. These colors, blended in the center, give the hues from green to blue, as indicated, and the blending of red and orange the hues from red to orange, which are approximately in harmonious contrast to their opposite hues, from green to blue. If the blue predominates, making a bluish green, its complementary will be an orange hue of red, and vice versa.

In summing up the argument on both sides perhaps it is fair to say that no inflexible line can be drawn between good and bad combinations. In the six standard colors the red, yellow and blue cannot be combined with pleasure to an educated eye.

Neither can the orange and the red, or the violet and the blue, or the green and the blue. On the other hand, the combinations of red and green, blue and orange, yellow and violet, although strong in the contrasts, are always pleasing to a child, or any one whose tastes have not been specially cultivated. If we show the child the contrast of red and yellow or red and blue and tell him it is "horrid" and then show him a neutral and a blue and say to him that it is "perfectly lovely," the probability is that he will fail to agree with us, and still prefer the red and yellow. But with a red and violet and a red and green the chances are that he will soon see the difference, and will thus be advanced one step. In view of all these things it becomes an important question with primary teachers how to begin the color instruction of little children. Some of them would at the outset restrict the pupils to the use of such combinations as accord with the best theories of harmonies and contrasts, giving them at first various colors, with tints and shades of the same or with neutrals. Others allow the contrasts of complementaries, and there are those who even think it better to permit the children for a time to use the standards at random, and only guide them in their selections as their eyes become trained. Many conservative kindergartners and primary-school teachers favor a medium course, between the two extremes. If the children are left to select such colors as they please for any length of time, without any instruction and guidance, they will make but little progress in color education, and may become so accustomed to bad combinations as to dull their natural perceptions. On the other hand, if they are never permitted to make bad combinations, which can be contrasted with those that are pleasing, one of the best possible elements of education is lost, because in all art instruction, where the values of the work depend on form and color, the comparison of the beautiful with the ugly can often be made the best possible means of education. In teaching color it is always safe to deal with the tints and shades of the same color, and they are generally more pleasing to children and others who are not

trained in this branch of education than the standards and neutrals. Whichever plan of instruction is adopted the teacher should follow some definite policy.

Owen Jones is often referred to as an acknowledged authority and his "Grammar of Ornament" as of great recognized value. As this work is somewhat expensive we make copious extracts from it and give complete his Thirty-seven Propositions, which he calls general principles in the arrangement of form and color in architecture and the decorative arts.

Proposition 1.

The Decorative Arts arise from, and should properly be attendant upon architecture.

Proposition 2.

Architecture is the material expression of the wants, the faculties and the sentiments of the age in which it is created.

Style in Architecture is the peculiar form that expression takes under the influence of climate and materials at command.

Proposition 3.

As Architecture, so all works of the Decorative Arts, should possess fitness, proportion, harmony, the result of all which is repose.

Proposition 4.

True beauty results from that repose which the mind feels when the eye, the intellect and the affections are satisfied from the absence of any want.

Proposition 5.

Construction should be decorated. Decoration should never be purposely constructed.

That which is beautiful is true; that which is true must be beautiful.

Proposition 6.

Beauty of form is produced by lines growing out one from the other in gradual undulations; there are no excrescences; nothing could be removed and leave the design equally good or better.

Proposition 7.

The general forms being first cared for, these should be subdivided and ornamented by general lines; the interstices may then be filled in with ornament, which may again be subdivided and enriched for closer inspection.

Proposition 8.

All ornament should be based upon a geometrical construction.

Proposition 9.

As in every perfect work of Architecture a true proportion will be found to reign between all the members which compose it so, throughout the Decorative Arts every assemblage of forms should be arranged on certain definite proportions; the whole and each particular member should be a multiple of some particular unit.

Those proportions will be the most beautiful which it will be the most difficult for the eye to detect. Thus the proportion of a double square, or 4 to 8, will be less beautiful than the more subtle ratio of 5 to 8; 3 to 6, than 3 to 7; 3 to 9, than 3 to 8; 3 to 4, than 3 to 5.

Proposition 10.

Harmony of form consists in the proper balancing and contrast of the straight, the inclined and the curved.

Proposition 11.

In surface decoration all lines should flow out of a parent stem. Every ornament, however distant, should be traced to its branch and root. ORIENTAL PRACTICE.

Proposition 12.

All junctions of curved lines with curved or of curved lines with straight should be tangential to each other. NATURAL LAW. ORIENTAL PRACTICE IN ACCORDANCE WITH IT.

Proposition 13.

Flowers or other natural objects should not be used as ornaments, but conventional representations founded upon

them sufficiently suggestive to convey the intended image to the mind, without destroying the unity of the object they are employed to decorate. UNIVERSALLY OBEYED IN THE BEST PERIODS OF ART, EQUALLY VIOLATED WHEN ART DECLINES.

Proposition 14.

Color is used to assist in the development of form, and to distinguish objects or parts of objects one from another.

Proposition 15.

Color is used to assist light and shade, helping the undulations of form by the proper distribution of the several colors.

Proposition 16.

These objects are best attained by the use of the primary colors on small surfaces and in small quantities, balanced and supported by the secondary and tertiary colors on the larger masses.

Proposition 17.

The primary colors should be used on the upper portions of objects, the secondary and tertiary on the lower.

Proposition 18.

(FIELD'S CHROMATIC EQUIVALENTS.)

The primaries of equal intensities will harmonize or neutralize each other, in the proportions of 3 yellow, 5 red, and 8 blue, integrally as 16.

The secondaries in the proportions of 8 orange, 13 purple, 11 green, integrally as 32.

The tertiaries, citrine (compound of orange and green) 19; russet (orange and purple) 21; olive (green and purple) 24; integrally as 64.

It follows that:—

Each secondary being a compound of two primaries is neutralized by the remaining primary in the same proportions: Thus, 8 of orange by 8 of blue, 11 of green by 5 of red, 13 of purple by 3 of yellow.

Each tertiary being a binary compound of two secondaries, is neutralized by the remaining secondary: As 24 of olive by 8 of orange, 21 of russet by 11 of green, 19 of citrine by 13 of purple.

Note. M. Bezold says concerning this: "It will always remain incomprehensible that even a man like Owen Jones in the text accompanying his beautiful "Grammar of Ornament" should have adopted this proposition in the form given to it by Field, since among all the ornaments reproduced in the work just mentioned there are scarcely any which really show the distribution of colors demanded by the proposition in question.

Proposition 19.

The above supposes the colors to be used in their prismatic intensities, but each color has a variety of TONES when mixed with white or of SHADES when mixed with gray or black.

When a full color is contrasted with another of a lower tone, the volume of the latter must be proportionately increased.

Note. Here "tones" is used in place of "tints," thus affording a striking example of the looseness with which terms relating to color are used, even by the best authorities.

Proposition 20.

Each color has a variety of hues, obtained by admixture with other colors, in addition to white, gray, or black: Thus we have of yellow, orange-yellow on the one side, and lemon-yellow on the other; so of red, scarlet-red and crimson-red; and of each, every variety of TONE and SHADE.

When a primary tinged with another primary is contrasted with a secondary, the secondary must have a hue of the third primary.

Proposition 21.

In using the primary colors on molded surfaces, we should place blue, which retires, on the concave surfaces; yellow, which advances, on the convex; and red, the intermediate color, on the under sides; separating the colors by white on the vertical planes.

When the proportions required by Proposition 18 cannot be obtained, we may procure the balance by a change in the

colors themselves, thus, if the surfaces to be colored should give too much yellow, we should make the red more crimson and the blue more purple, i. e., we should take the yellow out of them; so if the surfaces should give too much blue, we should make the yellow more orange and the red more scarlet.

Proposition 22.

The various colors should be so blended that the objects colored, when viewed at a distance, should present a neutralized bloom.

NOTE. The truth of this proposition is emphatically denied by M. Bezold in his THEORY OF COLOR, and in proof he states that the best specimens of fine art as well as decorative coloring do not in the least give the impression of a neutral gray when seen at a distance, but show a decided dominating hue.

Proposition 23.

No composition can ever be perfect in which any one of the three primary colors is wanting, either in its natural state or in combination.

Proposition 24.

When two tones of the same color are juxtaposed, the light color will appear lighter and the dark color darker.

Proposition 25.

When two different colors are juxtaposed, they receive a double modification; first, as to their tone (the light color appearing lighter and the dark color appearing darker); secondly, as to their hue, each will become tinged with the complementary color of the other.

Proposition 26.

Colors on white grounds appear darker; on black grounds, lighter.

Proposition 27.

Black grounds suffer when opposed to colors which give a luminous complementary.

Proposition 28.

Colors should never be allowed to impinge upon each other.

Proposition 29.

When ornaments in a color are on a ground of a contrasting color, the ornaments should be separated from the ground by an edging of lighter color; as a red flower on a green ground should have an edging of lighter red.

Proposition 30.

When ornaments in a color are on a gold ground, the ornaments should be separated from the ground by an edging of a darker color.

Proposition 31.

Gold ornaments on any colored ground should be outlined with black.

Proposition 32

Ornaments of any color may be separated from grounds of any other color by edgings of white, gold or black.

Proposition 33.

Ornaments in any color, or in gold, may be used on white or black grounds, without outline or edging.

Proposition 34.

In "self-tints," tones or shades of the same color, a light tint on a dark ground may be used without outline; but a dark ornament on a light ground requires to be outlined with a still darker tint.

Proposition 35.

Imitations, such as the graining of woods, and of the various colored marbles, allowable only when the employment of the thing imitated would not have been consistent.

Proposition 36.

The principles discoverable in the works of the past belong to us; not so the results. It is taking the end for the means.

Proposition 37.

No improvement can take place in the Art of the present generation until all classes, Artists, Manufacturers and the Public, are better educated in Art, and the existence of general principles is more fully recognized.

CHAPTER X.

THE BRADLEY SCHEME OF COLORED PAPERS.

HAVING set forth in the preceding pages what seem to be the essential points in the science of color and the apparent needs of an adequate color education, it is now in order to suggest methods of study for the pupil and materials best adapted to such study.

In all color education the color feeling must be cultivated, and in the primary grades this can be better done with ready-made colors, if correctly adjusted, than by the combination and application of pigments. While the truth of this proposition has been readily accepted in the abstract by many of our best kindergartners and primary-school teachers, the absolute want of any such adequate material has seemed to necessitate the introduction of water colors as the best-known medium. In the use of paints in water or oil the attention of the child must be divided between the study of color and the methods of manipulating the pigments, and in the seeming necessity for selecting water colors in preference to oil, on the grounds of economy and conveience, a material has been adopted with which it is exceedingly difficult to produce a flat surface of a full color, and which, while adapted to most beautiful effects in lighter tints, is entirely unfit for primary instruction in color.

To meet this demand for prepared material the Milton Bradley Company are manufacturing a line of colored papers which are designated by symbols having a definite meaning, derived from the scientific study of color as briefly explained in the foregoing chapters. It has often been urged against

colored papers that because in some of them arsenic is used they must be dangerous for children to handle, and for this reason no arsenic has been allowed to enter into the composition of these papers. The whole collection has been prepared after a long series of careful experiments, and includes all the hues, tints and shades necessary for thorough elementary color teaching. These colors contain and are based on the six spectrum standards and are believed to fulfill the requisite conditions for color teaching in the primary grades and come as near perfection as has thus far been possible in the attempt to match the liquid immaterial colors of the spectrum with material colors. By combining the use of these colored papers with that of the rotating colored disks the average teacher can lay a broad foundation in contrasts and harmonies of colors. Having secured such a foundation, it will be an easy matter for the teacher to produce a large variety of other colors with pigments in water or oil which will be of great value.

In using these papers, after the pupils have become familiar with the six principal spectrum colors and black and white, the first combinations to be made are the six colors with their respective tints and shades and the grays.

In order to show tints and shades, the assortment contains two tints and two shades of each of the six colors, which provide sufficient variety for educational purposes, although it is evident that there may be an infinite number of shades and tints of each color. Having exhausted the value of this selection of colored papers, the teacher can avail herself of a second collection comprising the spectrum hues between the standards with one tint and one shade of each, which is made up as follows: Orange-red, red-orange, yellow-orange, orange-yellow, green-yellow, yellow-green, blue-green, green-blue, violet-blue, blue-violet, red-violet, violet-red.

In addition to these colors the assortment contains combinations of orange and green, orange and violet, violet and green, blue and red for purples, and also a purple with the orange and with the green. To these will be added any further colors

which experience shall prove to be necessary, but with the design to keep the line as simple as is sufficient for primary educational wants. We do not hesitate to claim that this combination can be made to do better class-work as far as pure education of color sense goes than can be possibly secured by the use of anything short of a good pallette of oil colors. In making this statement we have no desire to overlook the value of technical experience in the use of either water or oil colors. The use of these materials will be in order in the school-room as soon as the ability to draw is so far advanced that the children can produce the necessary outlines and designs within which to neatly place the colors.

Perhaps a word of explanation regarding the way in which the standards have been determined may be helpful here, although the matter has been stated more fully in a preceding chapter. In deciding the exact hues to be called standards we have regarded the general opinion or impressions of as many students of color as could be conveniently consulted. As a consequence, in the red we have selected the deepest red, instead of an approach to the vermilions or the carmines. The orange is a natural pigment which is a nearer match to the pure orange of the spectrum than can possibly be made from any red and yellow pigments. As there is very little yellow in the spectrum and what we do find is not very intense, the quality of the color impression at the dividing line between the orange and the green is imitated, but possibly with somewhat greater intensity than the actual facts will warrant.

The blue is the hue commonly known as pure ultramarine, which is recognized as the nearest possible match to the spectrum blue that can be found in pigments, although we have been more accustomed to a blue with a tint of red in it, which is a softer color in many combinations. The violet will probably be a disappointment to many, because they will regard it as not deep enough, having been used to a deep blue purple for the sixth color, but our violet is the spectrum color and the deeper color must be made by other combinations, as it is

not found in the spectrum. To sum up the whole matter, the intended use of the spectrum has been to merely get a line of standards from which by combinations to produce a line of educational colors acceptable to the color-educated eye and in accordance with the science of color.

CHAPTER XI.

COLORED PAPER IN THE SCHOOL-ROOM.

BY MISS JEANNIE C. McKECHNIE.

THE teaching of color has until recently been considered as belonging only to the specially gifted ones who hoped to become colorists, either for personal enjoyment or as professional artists. At the present time there is increasing interest in this subject and all leading educators are giving their best thought to it. It would be arrogant indeed to-day to lay down any fixed laws or methods to be followed as the best way of teaching color. Of necessity all color work in our schools must be experimental. As an educational problem it is still to be solved. But we can at least make sure that the foundations we lay are safe and true, that those who follow us may not have to undo and build better, but may build upon what has been already laid.

Let us look for a moment at the reasons for color teaching in our schools. All our progress in educational lines has been the result of the psychological study of the child's mind, the seeing things through his eyes, and judging them from his stand-point. We know that what the child sees in life depends much upon what he is trained to see in school. We are seeking to develop the child in all points symmetrically. The element of color enters as an influence into his life at a very early age. The love of color is as much a part of our nature as the love of music. Color is not as important as form. I question if it assists in developing form. It is an ornament to it, but

does it not to some extent disguise it? We want to lead the children to appreciate thought in color and to interpret and express thought through color. When once we see keenly enough, there is no trouble in representing what we see. We wish to develop the aesthetic nature of the pupil and prepare him for the enjoyment of all the beautiful and true in nature and art. "The beautiful is true, the true must be beautiful."

The principles underlying the science of color must become more than mere theories to him. They must be so applied by him that the interest in application will forever fix them in memory. Any method of work which helps to bring out of a child that which God has put in him, making his work a delightful discipline of mind and body, is a right method. A true teacher knows how much value to put on the teaching which brings the sparkle to the eye, and arouses all the self-respect and manliness in a boy conscious of having done a piece of work well. In the teaching of color we have a double advantage in that it is beautiful in itself. It holds in itself its own attraction for the children.

True, there is a practical side which must not be ignored, neither should it be overestimated. In the words of John Ruskin: "Try first to manufacture a Raphael; then let Raphael direct your manufacture. He will design you a plate, or cup, or a house, or a palace, whenever you want it, and design them in the most convenient and rational way; but do not let your anxiety to reach the platter and the cup interfere with your education of the Raphael. Obtain first the best work you can, and the ablest hands, irrespective of any consideration of economy or facility of production. Then leave your trained artist to determine how far art can be popularized or manufacture ennobled."

Whatever scheme of color teaching is decided upon, two lines of thought must be followed. First, the development of the color sense; second, the expression by some color material of the color sensations made upon the brain. Here we must decide too, upon one of two distinct lines of work, construc-

tion and decoration, or true painting, and in our choice we must be guided by careful thought. At many points the two coincide, yet the principles of color underlying them are different, and it follows of necessity that the uses of color in its application to them must be different.

As soon as the child makes pleasing arrangements with solids or tablets he has begun his work in construction and decoration, and as soon as the element of color enters into these combinations the teaching of color should begin.

In the development of the color sense, teach always by comparison. The reasons for this have already been set forth in the previous chapters. The careful teacher should soon be able to detect any marked degree of color blindness. In this branch, as in all others, some show quick perceptions, while others are dull, yet only a little more time and patience may prove that the perceptive faculties of the dull are really normal.

At first, simple arrangements of tablets may be used. Following the teaching of the sphere, pleasing arrangements of colored circles may be taught. Begin with simple repetition, using but one color, and for this first work use one of the standards. Then teach alternation, using a standard and its tint. Very pleasing borders can be arranged in this way. Following the study of the cubes, similar arrangement in squares can be given; next introduce the use of the shade. Lead children to see a scale of color ranging from light tint to dark shade. Tell the children little, lead them to see much.

When the cylinder is studied the oblong is added. After the hemisphere the semi-circle. The quatrefoil can now be introduced. Simple rosettes can be made, teaching repetition round a center. In all work in design the center should be one fifth the diameter of the background. Place units so as to cover the background well.

As many of our primary schools have the kindergarten folding and weaving, the color lessons should apply to these as well. All who have the sewing cards, so useful to fix patterns of solids and pleasing designs, have another opportunity of

applying the color teaching, as the thread is manufactured in the standards. In short, do not allow the children to simply construct pretty things. Make all this work an application of the color lessons. In the first year's work confine all combinations to standard and tint, or standard and shade.

The teacher should understand the science of color, but it is not necessary or wise to attempt to teach it in the school-room to young children. The child if left to himself will often choose a combination of bright colors not at all pleasing, perhaps even false to all principles of true harmony. The teacher should so guide her work as to make inharmonious combinations impossible. The child will thus receive an unconscious training in the principles of true harmony. There are simple combinations of beauty and strength, and it is wise to adhere to these in our first lessons.

In the second year the work of the first should be reviewed. Patterns of the solids can be pasted in colored papers and cut out and folded into the hollow form. As the triangular prisms are studied we have opportunity for many new designs with the triangles and in combination with forms previously studied. Now combine two tints or two shades of the same color, in addition to the combinations of the previous year. The four-pointed star, the Maltese, Greek and Latin crosses and other pleasing forms may be folded, and cut from the 4-inch colored squares. As the ellipsoid and ovoid are studied, borders of ellipses and ovals cut in color by aid of tablets, and designs, using these as units on a colored background, may be introduced. Be careful to adhere to the same law of design and of color combinations. The background of a standard and the units of a tint, or the background of a shade and the units of a standard or tint of the same color, are safe combinations.

Fix the scales of color. After the study of the cone and pyramid the new triangle, isosceles, is introduced, from which pleasing borders and stars may be made. The full pattern of the square pyramid makes a very pretty basket which the children delight in when cut in color.

In the third year, after reviewing the color work of the two previous years, we can enlarge our work by the teaching of hues and contrasts. This brings us to the more scientific study of color, some principles of which can merely be outlined in the present chapter.

In all our previous combinations we have chosen two colors from some part of the scale of one color. We have avoided any combinations of two standards. Let us now look at a reason for this. We wish to hold the children to the truth in nature and art, as expressed in decoration and painting. Volumes have been written on this subject, teaching has been carefully and wisely given, and yet we are constantly having our color nature shocked by bad combinations in design and dress. We want to so teach that no woman will enter church with a violet gown and a bonnet trimmed with blue forget-me-nots, a combination which made me shudder as I looked at it and knew that it was worn by an educated woman and a teacher.

Ruskin tells us: "As to the choice and harmony of colors in general, if you cannot choose and harmonize them by instinct, you will never do it at all." Yet I have seen children, who, when they first entered school, would be delighted at loud and coarse combinations of red and yellow, green and purple, etc., but after three years careful teaching would express their feelings toward such combinations by a shrug of the shoulders and a very wry face. Ruskin was no doubt right in that none can become true artists, without the inborn artistic feeling for color. To such color becomes poetry, and they will instantly perceive the color melodies in nature. But we can do much to teach the prose of color to the masses, making them far better qualified to understand and appreciate and be uplifted by the true poems from the hand of a more gifted genius.

The proper combination of colors in a picture or design produces harmony. The following proposition has often been given and is largely accepted: When colors are so combined that the mixture of the whole will produce a neutral gray, then we have true harmony.

This proportion has been given as 5 parts red, 3 yellow and 8 of blue; also 8 parts orange, 11 green and 13 purple will produce the same result, and 19 parts citrine, 21 parts of russet and 24 parts of a mixture of olive green and purple. But some scientists disclaim this rule entirely, saying it is based on false conclusions and if strictly adhered to will give very unpleasant results. While we may teach the children to make simple and harmonic combinations, the problem of the exact balancing of colors must be left to the true artist.

Every color has its complementary. A color placed beside its complementary increases the luminous power of both. Red is much more brilliant when seen beside green, blue with orange, yellow with purple. As has been before stated, if we consider the spectrum as a chromatic circle, the colors coming opposite each other would be complementary, that is, they will be in harmonious contrast. If we put red and purple together we feel at once the discord; there is no harmony in the contrast, each is harmful to the other. If we place red with green, we at once feel the harmony, yet the contrast is too loud and coarse to give us pleasure. The same is true of blue and orange, yellow and violet in their full strengths. As a result of the contrasts we have force, not necessarily the lack of harmony. Primarily then, never use the complementaries together in their full strength. Many of their delicate tints, deep shades and hues can be employed with beautiful effects.

The children can easily be taught to perceive the complementaries by experiments similar to those noted in Chapter IX.

Each color seems to surround itself with its complementary color. As soon as the eye is fatigued with one color it is not able to see it, and its complementary comes in its stead.

We should not think of contrast and harmony as the reverse of each other. We may have harmony either with or without contrast. Colors are continually affected by their surroundings. Harmony must guide compositions, but if contrasts are introduced the effect should be rather in the nature of a surprise than a shock.

Colors are often materially changed by placing them on different backgrounds. A large number of experiments can be used to illustrate this fact. One set which may be easily prepared for use in the third year's work is as follows: Take sheets of paper about 10 x 12, varying in color from pure white, through light gray and dark gray to black. Place 4-inch disks of pale blue paper in the center of each. Then lead the children to observe results. On the white the disk appears the true color, on the light gray it becomes somewhat paler, increasing in paleness on dark gray, while on the black it appears almost white. Change the color of the disk, using all the colors in turn.

An anecdote illustrative of this point is told by Chevreul in his great work on the simultaneous contrasts of colors. Certain dealers wished to ornament some blue, violet blue and plain red woven stuffs with black patterns, so the directions were given to the manufacturers. When the goods came back the dealers thought them wrong and declared the patterns were not black. Those traced on the blue were copper colored, those on the violet, dark greenish yellow, and on the red, green. Chevreul covered the goods with white paper, so that only the traced patterns could be seen, when it was found to be a true black, the previous effect being entirely due to contrast. Had the pattern been made by black mixed with a slight tone of the ground, instead of pure black, the effect would have been what the manufacturers wished.

When contrasting colors differ much in strength, the weaker one will seem still more feeble and the darker one more intense, unless the colors are complementary, when each will be rendered purer and more luminous.

Many of our most beautiful effects are made by careful and varied gradations of color, the orderly succession of tints gently blending into each other. Some of our finest artists owe their triumph far more to gradations than contrasts. Ogden Rood draws a parallel between the effect of gradation in color and the effect of modulation of tone and thought in oratory.

The foregoing are but hints of the laws governing contrast and harmony, but our space does not permit more. Teachers should make themselves well acquainted with this branch of the science, that their application for the children will not deny the truth.

The teaching of hues of the colors will be a little more difficult, but if the teacher has the rotating disk, the work becomes very simple.

We have studied color in its three degrees: Tint, or color lightened, standard color or its natural appearance and shade, or color darkened. Hues are obtained by combining a small portion of one color with another color. If we combine a small portion of orange with red we have an orange hue of red, etc.

The application of these in combinations for design give us a very large field to choose from, and truly artistic designs can be made. Avoid all strong contrasts.

Beside the work in design, ornamental patterns of shields, fans, stars, etc., can be made from the papers. As the scales of color are furnished in the hues as well as the standards, the same rule of composition as before may be effectively used. All colors may be safely employed with neutral grays, although some will be rendered more luminous, others less so.

If at the end of the primary work, the children have thoroughly mastered the standards of colors, their tints and shades in a full scale of color, the hues and their scales of color, and the complementaries, they will have gained such a knowledge that nature will become to them a new language, because their eyes have been opened to perceive its manifold beauties and endless harmonies.

The accompanying thirty-six suggestive designs are presented to aid teachers in the use of colored papers or water colors, and illustrate repetition, repetition and alternation, repetition around a center and surface coverings.

Figures 1, 3, 19, 22, teach simple repetition, using but one color.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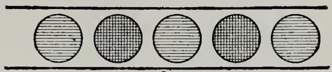
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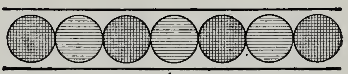
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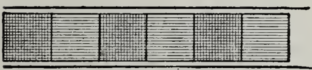
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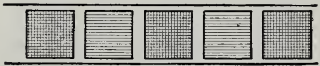
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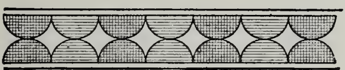
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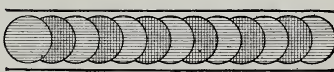
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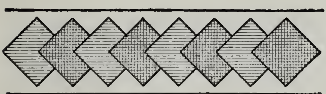
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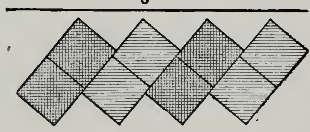
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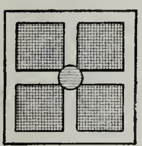
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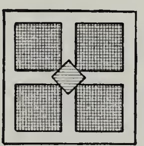
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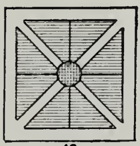
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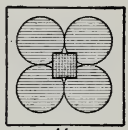
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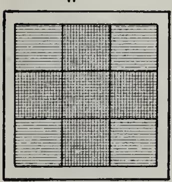
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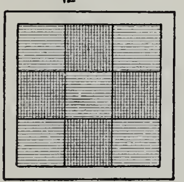
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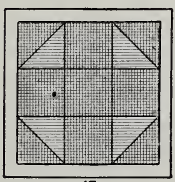
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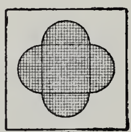
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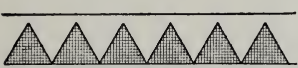
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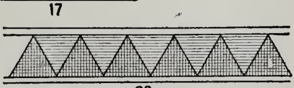
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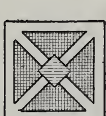
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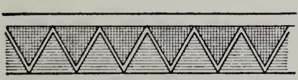
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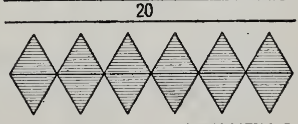
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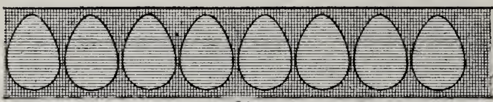

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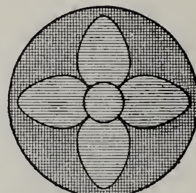

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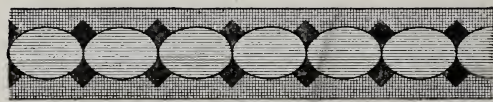

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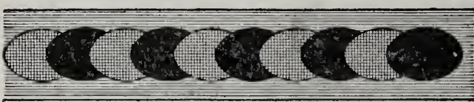

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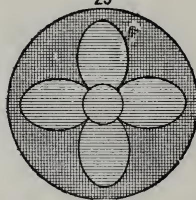

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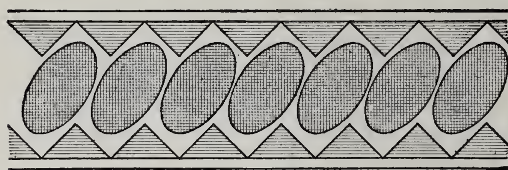

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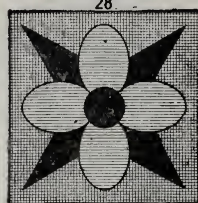

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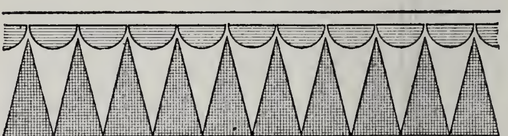

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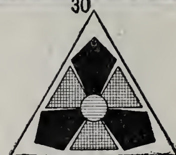

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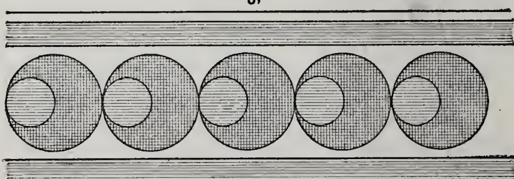

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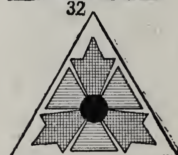

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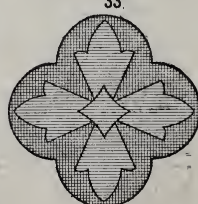

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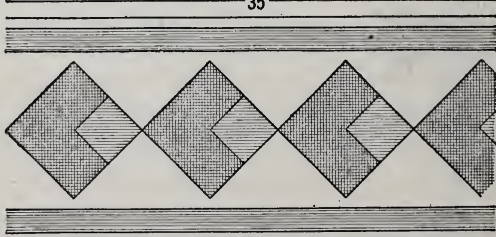

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Figures 2, 4, 5, 6, 7, 10, 20, 21, teach repetition and alternation, using a standard and tint, or standard and shade, or tint and shade of the same color.

Figures 8 and 9 teach overlapping, using two tones from the same color scale.

Figures 11, 12, 13, 14, 23 teach repetition about a center. For colors use combinations as in borders described above.

Figures 15, 16, 17, are arrangements for all-over designs, suitable for tiling.

Figure 18 is the quarterfoil made by pasting four semicircles touching the edges of a square.

Figures 24, 26, 27, are borders made on a colored background. Use two or three tones from the same color scale, or combine tones of the same scale with a neutral gray.

Figures 25, 28, 30, 34, are repetitions around a center on a colored back-ground.

Figure 29. Arrange ellipses of one color and triangles of a tint of the same color.

Figure 31. Use all triangles of one color and semi-circles of a shade or tint of the color or the reverse.

Figures 35, 36. Add the horizontal colored strip at the edges. It is pleasing when made of neutral gray or the same color as one of the units.

Figures 32, 33. Use a color with its tint and shade or a neutral gray.

These designs and many others constructed on the same principles may be made with water colors as well as in the colored papers, but in water colors the designs should be larger to allow free handling of the brush.

CHAPTER XII.

WATER COLORS IN THE SCHOOL-ROOM.

BY MISS JEANNIE C. McKECHNIE.

IN the preceding chapter we have sought to show some of the reasons for teaching color and have given some suggestions as an aid to such teaching with the colored papers. There is good reason why the use of paper should precede that of any other color material, for in the papers as now manufactured we can get truer standards and purer scales of color than by paint or pigment in the hands of the children. But having gained the foundation work with the papers, having trained the children to accurate perceptions of color, they are now ready to express by paint these color impressions which they have been receiving. By the cutting and pasting lessons they have been trained to acuteness of thought, carefulness in application, neatness and accuracy, as well as in color sensations.

In the teaching of color by the use of moist paints the children meet with many difficulties which can be overcome only by the most careful teaching and patient practice.

The use of paints involves a method in application, and the children should be taught how to paint while learning the principles of correct coloring. All methods, to insure success, must be systematic. In the teaching of water colors, then, we should begin at the foundation.

Of necessity, the first thing to be considered is the selection of materials. I do not feel that the cheaper color boxes yet contain all the elements of success in the teaching of color,

still some excellent results are being obtained by them. The brushes of the small boxes are comparatively of little value, as they are by far too small to allow any bold, free, wet handling. As delicate lines and points can be made with a large as with a small brush. Each child should be provided with paints, brush, color block, blotter or soft cloth, and, if possible, a sponge to absorb superfluous water from the brush. The block should rest on an inclined surface. That of the desk is usually not sufficient, a slant of about 5 inches in 12 inches being required.

The first lesson should consist of instruction in the use of materials, i. e., how to fill the brush with water, turn it to a good point, how to take out color from the pan and mix it in the mixing tin. The next step is the making of a flat wash. It is often wise, especially with young children, to teach the use of water alone at first, until they have learned to follow directions.

After filling the brush moderately full of water begin at the upper edge of the surface to be colored, working with the side of the brush from left to right and from the top downward, using the point of the brush only for lines and filling in corners. The brush should be kept full. All superfluous water will flow downward and collect at the bottom, where it can be taken up by blotter or cloth, or the brush itself, partially dried and flattened and then just touched to the paper. Care should be taken not to allow the brush to come outside the lines.

When the children have learned to follow these directions, they are ready for the color wash, which should be applied in the same way. Oblongs 2 inches x 4 inches are none to large for these first lessons, where we wish to gain, as before stated, a bold, free, wet handling.

The result should be a perfectly even flat wash. If the children work too slowly, some of the color will dry before the next stroke of the brush touches it. If the brush is not replenished often, the wash will look uneven, because the color grows lighter as the brush exhausts itself and the next appli-

cation will have more color, thus giving the wash a cloudy appearance. The color should be flowed over the surface without rubbing it in and there should always be a puddle of water entirely across the space being closed while the brush is being replenished.

It will be found that tints will be laid on much more evenly than full colors, and the most artistic coloring is by repeated washes of the tints, but this is too difficult for the children at first, and it is wiser to let them put on a heavier color in one wash. If three oblongs are drawn on the pads, one may be colored red, a second yellow and the third blue.

The children should next be taught to make a scale of color. White should never be used in water colors, as the addition of water will produce tints from the deepest to the most delicate. These can be taught either by the mixing of tints of varying tone and applying each separately to a surface, or by a graded wash. This consists in starting with the full color and by gradually adding water, ending with the palest tint that can be made. Then start with the full color and gradually add full black or neutral tint to end with the deepest shade. The scale consists of the color from lightest tint to darkest shade, or the reverse. Neutral tint gives much more delicate shades than the black. Full scales of red, blue and yellow should be made.

Following this comes the teaching of the mixing of colors. The children now learn that yellow and blue will make green, that yellow and red produce orange, and red and blue give purple. We may make a choice of designs to apply these colors. Circles may be drawn. Divide one into halves, leaving a small space of white along the diameter. Color one half blue, the other half yellow. Below draw a circle of the same size, filling it with green, the color obtained by mixing the two. In the next circles, use red and yellow in the same way with the full circle of orange and in the third, red and blue and the full circle of purple. A teacher's tact and experience will guide her in her choice of designs. Scales of green,

orange and purple should follow this in the same way as the preceding scales.

We can now apply these washes to simple designs. As accurate drawing is necessary in all designs, the tablets may be used to advantage in preparation for the color lesson. Borders similar to those that have been arranged from the colored papers and afterward drawn, can now be colored. Avoid all coarse and loud combinations or strong contrasts. Much work in the simple coloring should be given before complementary or harmonic coloring is attempted. In short, the suggestions given in the preceding chapter apply with equal force to the combinations of water colors.

Dulled scales of color should be taught. These are made by mixing neutral gray with all the tones of the scale. These are often much pleasanter in combinations than the colors in their full strength. Any color may be used with a neutral gray. The same law of harmonies as stated in the preceding chapter holds true and need not be repeated here.

Many very pleasing designs may now be made by adding a background either from the same scale of color as the units of design or some tone of gray. If any contrasts are used let them be of the most delicate nature. I think it wiser to avoid them altogether in the first lessons. It seems to me a subject the application which can be safely left to higher grade work, as it requires the most careful thought to use them in their proper and pleasing proportions.

Then the mixing of the so-called tertiaries, citrine, olive and russet may be given. Orange and green make citrine, or the yellow tertiary, orange and purple make russet or the red tertiary, purple and green make olive or the blue tertiary. The teaching of each new color should be followed by its scale of color.

The secondaries and tertiaries harmonize after the same law as the primaries. For instance, if you wish the tertiary which harmonizes with orange, recall the primary which harmonizes with orange, which is blue. Then the blue tertiary or olive

will harmonize with orange. The harmony between secondaries and tertiaries is much more subtle and delicate than between primaries and secondaries.

A large wash of a tertiary with an outline or a touch of a primary gives very pleasing effects. Outlining units in design with tints or shades of their own color also gives pleasing effects through contrast.

All these may be applied in borders, rossettes, bilateral forms and face designs, though for the first few years I would confine the work to large surfaces, leaving the designs of the small units until the children are perfectly familiar with the handling of the brush and application of color in a flat wash.

In all designs arrange the units to cover the surface well and be careful to have well-balanced margins.

The effect of different backgrounds on the same color may be taught by painting a central disk of color and surrounding it by backgrounds of varying tones.

In connection with the theory of color the children may be taught the representation of form if there is but little roundness. Leaves from nature, some insects, butterflies, moths etc., so placed as to show little perspective may be easily accomplished. Color in the round should not be taught until the pupils have a thorough understanding of light and shade. In connection with the study of botanic analysis the coloring of the different elements of motives from plant life may be taught. These can then be used in design. From this we can go on to historic ornament in teaching the different styles.

These are but suggestions of a most interesting and attractive line of work. Know thoroughly what you ought to do "Make the theory of the subject your servant. Do not be a slave to its laws."

SAMPLES OF COLORED PAPERS.

We append a number of samples selected from the educational colored papers prepared by Milton Bradley Company for primary instruction. This selection comprises less than one half the entire line, and contains the six spectrum standards and two intermediate hues between each two standards. Beyond these there is a somewhat miscellaneous selection of the tints and shades of these standards and various combinations of the orange, green violet, etc. The samples are designated by symbols, in which R. is red, O. orange, Y. yellow, G. green, B. blue, V. violet, T. tint, S. shade. P. is introduced for convenience, although it should be composed of R. and B. As there are in the full line two tints and two shades of each standard the numbers 1 and 2 are used. Thus "R. T. 1." is red tint No. 1, "R. S. 2." is red shade No. 2, "Y. G. S." yellow green shade, etc.

Little practical use can be made of colors bound into a book, because they cannot be re-arranged and contrasted with each other separated from the other colors by which they are influenced, but they are valuable as illustrating something of the systematic methods of teaching which are made possible with selections from the entire list. We also hope that the nomenclature will prove of special interest as designating colors which have long been familiar under meaningless names.

The following list of letters indicates the colored papers in the order which they occur, the collection comprising samples of about one half the colors which we manufacture:—

R. T. 1.	Y. G.	V. T. 1.	O. & V.
R.	Y. G. S.	V.	V. O.
R. S. 2.	G. T. 1.	V. S. 1.	V. O. S.
O. R.	G.	V. S. 2.	V. & G.
R. O.	G. S. 2.	R. V.	G. V.
O. T. 1.	B. G.	V. R.	G. V. S.
O.	G. B.	R. P.	O. & P.
O. S. 1.	G. B. S.	P.	P. O.
O. S. 2.	B. T. 1.	B. P.	P. O. S.
Y. O.	B.	O. G.	P. G. S.
O. Y.	B. S. 2.	O. & G.	G. & P.
Y. T. 1.	V. B.	G. O.	G. & P. S.
Y.	B. V.	G. O. S.	G. P. S.
Y. S. 2.	B. V. S.	O. V.	Gray 2.
G. Y.			

R. T. I.

O. R.

R. O.

0.

Y. O.

O. Y.

Y. T. 1.

Y.

G. Y.

Y. G.

Y. G. S.

G. T. 1.

G.

B. G.

G. B.

B.

V. B.

B. V.

V.

V. S. I.

R. V.

V. R

O. G.

O & G.

G. O.

G. O. S.

O. V.

O & V.

V. O.

V.O.S.

V & G.

G. V.

G. V. S.

P. O.

P. G. S.

G. & P.

G. & P. S.

G. P. S.